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# Topo-morphological Investigations on the Relation between Stem and Leaves and their Bearing on the Phylogenetic Systematics of Vascular Plants. Part 1

By

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With 1 Table, 20 Figures and 3 Photographs in the Text

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## 1. Preface

The structures of stem and leaves of vascular plants have long been investigated by various taxonomists and morphologists, both externally and internally, and the descriptions and observations obtained were so abundantly accumulated that it seems rather difficult to review them and to grasp the outlines of the common characters of the group.

The origin of angiosperms is still obscure and, at the same time, one of the most attractive items in the field of botany. To solve this problem, from various points of view, many characters of the group have been used as tools. For example, Lam (1948) has taken principally the sporangia-bearing mechanisms (stachyospor and phyllospory), Yasui (1951), the organizations in the embryonic tissue of the group, and some, carpological data, etc. Among them

I. W. Bailey and his school have been greatly advanced the matters, researching them from a wide scope and using various methods, which are carpological, wood anatomical, outer morphological and palynological, etc. Although the results to be obtained seem to be promising, the matter has not been satisfactorily solved. On the other hand, as to whether the origin of angiosperms is polyphyletic or monophyletic, some recent researches (Fagerlind (1947), Lam (1947), Hu (1950)) have suggested that the former is probable.

The writer has been investigating this problem these ten years, from his own standpoint and the results obtained have already been published in several papers.

He has viewed from the standpoint that besides the reproductive parts, the vegetative ones are very valuable in the phylogenetic researches, as they take the important and indispensable roles in the life cycle of the plant. Under these circumstances he has attended his attention especially to the relations between the stem and the leaves grown on it. He pointed that the peculiarity in the vascular course of *Ginkgo* flowers and petioles in its short branch, is one of the distinct relics of ancient dichotomy in the stem system and that it gives us a substantial clue to the clearing of the problem (1948). He also suggested in the same paper, the affinity of *Ginkgo* to the fern group, Ophioglossales, from the similarity of the vascular organizations. In 1949, he investigated the constructions of the bud and bud-scales of *Zelkova serrata*, *Cyclobalanopsis acuta*, *Fagus crenata*, etc. and established a new hypothesis, the synthetic origin of stipules by means of insertion. Another short report about this hypothesis with some new examples was delivered at the morphological session of the 7th International Botanical Congress at Stockholm in 1950. Later, the writer has consolidated the concept of the 'leaf class' and 'leaf phase', dealt with most broadened leaf and leaf derivatives including both axillary stems and inflorescences as a whole and integuments in the case of Caytoniales (1950). In these two years from the publication of the latest paper of the present writer on the items, both his considerations and researches have been so widely extended, that it seems to be a good opportunity to summarize the results and to apply them to the phylogenetic system of vascular plants.

## 2. Stem and Leaves under the Topo-morphological Concept

### § The enlargement of the morphological unit, "leaf"

According to the ordinary and hitherto acknowledged morphological categories, the leaf is a two-dimensional mass of accessory to the stem and has a vascular bundle or bundles in its texture. Therefore, the emergences upon the stem of *Psilophyton*, in which any vascular bundle cannot be traced in



their tissue itself, in spite of the occasional existence in the part of the stem with which the emergences directly come into contact, are not treated morphologically as the leaf and it is still less in the scales upon the stems of ferns, and in the ligules of *Selaginella*, etc. It is clear that these restrictions of the range of the category is very artificial, when we accept, in another side, the evolutionary changes of the leaf from the ones scaly emergence to those of normal laminal state, and that the enlarged category of the leaf which will cover those evolutionarily primitive organs, will be natural and reasonable. We must accept the matter as that of variably changed or changing through the evolution in the four dimensional extensions (substances in three dimensions with the time, the fourth one).

As we see in the facts paleontologically ascertained, vascular plant had started as a mass of tissue prepared with a simple tracheal system, to which condition we may apply the word "stem" correctly. In other words, the first occurrence of vascular plant had been made up of a stem, while in later stage the leaf appeared on the stem. These facts must be taken into consideration when we investigate into the relations between stem and leaves. The modes and courses of these leaf formations are permitted theoretically in many but quite different ways from each other and that to trace back discriminately these different ways must be just the only, but the reasonable, method upon the phylogenetic ground to bring a natural classification into the vast embers of vascular plants.

The writer will define the leaves as the matters which are appendants to the stem including ones which are capable of being a stem secondarily. And the writer accepts as the leaf the following matters hitherto received as the different organs or merely the appendaged small organs.

The scales and emergences on the stem, ligules, axillary sporangio-phores, axillary inflorescences, axillary vegetative shoots, and the integuments of ovules.

The reasons under which these matters have to be treated as leaves, will be touched in the following pages.

The stem consists of two parts, the basal vegetative one and the apical reproductive one. Whether which of these two parts had appeared earlier than the other, is the matter of fundamental importance. To decide this, we have to consult the life cycle of vascular plants. Vascular plants has, as a rule, a perfect bicyclic life cycle<sup>1)</sup> in which it occurs every two sporic, and two thalloid, stages (Fig. 1). A sporic stage consists of the genuinely sporic and the other gametic one, both of which have no relation to the matter discussed in the ranges concerned. The thalloid stages are gametophyte and sporophyte, in spite of the former being out of our range, the latter is much important, being

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1) Maekawa, F. in Journ. Jap. Bot. 23: 33-42 (1949)



differentiated as stem and leaves. When sporophyte may produce spores in the sporangium, the cycle can go round along the course to the sporic stage, but, if not, the sporic stage cannot be reached and the result is the stopping of the cycle, at the same time, the death of phylogeny. In this respect it is clear that

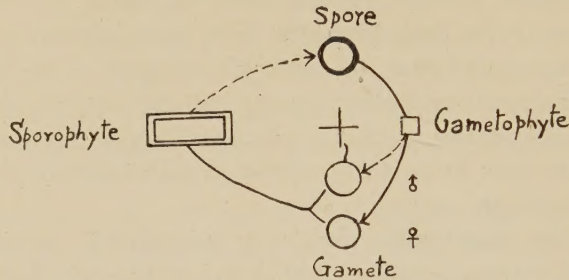


Fig. 1. Diagram of the life cycle of vascular plant. The cycle rounds clockwise. Sporic stages (genuinely sporic and gametic ones) in the vertical axis, while thalloid stages (sporophyte and gametophyte) in the transverse axis. The arrow means the separation of sporic stage from the thalloid ones.

the spore formation is necessary in the life cycle from the phylogenetic points and necessitates the sporangia formation on the sporophyte. Therefore, sporophyte may lack the vegetative part, but cannot destitute the reproductive part, sporangia. That the sporangia is the first existence, followed by the vegetative part is important in connection with the formation of some kind of leaves. It is reasonable that the establishment of a kind of leaves upon the reproductive part as an emergence origin, might occur independently against the following establishment of the other kind of those upon the vegetative part, which is produced in some later period, of the stem.

#### § The doubts in the basic concepts hitherto accepted and some radical suggestions to emend them.

The present leaf form, as we can see, is most impressive, but is not always the fundamental one and contains two different categories in it. So the writer will segregate and accept these two categories, the first as, leaf phase, and the second as, leaf class, respectively.

The **leaf phase** is the present status of the leaf in broad sense and must be morphologically and physiologically defined. It may transform from one to another in its evolutionary period and also even in the ontogenetical short period. While the **leaf class** is the phylogenetically defined group for the possibly same origin, but not concerning the present leaf phases that the plant takes. The wide range of the metamorphosis in the leaves is broad as just mentioned above as to cover from axillary branch to integument of ovules and coincide with the range of the leaf phase as a whole. But the range of the leaf phases in each leaf class is not always the same in each other.



As to the polyphyletic origin of the leaf, the predecessors of the stelar theory have recognized the two kinds of different origin, i. e. microphyll and macrophyll in connection with the absence or presence of leaf gap or gaps. The writer partly adopted this theory but abandoned the part concerning leaf gaps, which are the matter of stelar characters of the main stem but never that of leaves and stressed the importance of analysing the leaf constructions topo-morphologically till to obtain four different leaf classes.

Furthermore, the writer suggest an important emendation about the occurrence of leaf classes in that they may be found sometimes independently or sometimes, in various degrees and manners, accompanied by the different leaf class members, not only upon the same group, but in the same place of an individual. This is the concept of the **characters of 'many-sidedness'**. Under this concept, characters both taxonomical and physiological, may be divided into two categories, the one is the above-mentioned characters of many-sidedness and the other is **the characters of tendency**. These two can be discriminated as follows.

**Characters of many-sidedness:** They perform the same or almost the same physiological functions and take a similar forms and constructions which may be called as analogous. Two different kinds of these characters can be found in symphonic in the same place even at the same time, but cannot transform each other. Also most of them once settled to the definite ones, are not easy to change but remain through the long period of the evolution.

**Characters of tendency:** They perform quite different physiological functions and may or may not take a different forms and constructions. They may belong to the same class, in this case alone we call them to be in homologous, or may belong to quite different group. In the same individual, they often easily transform each other, but cannot occupy the same place in the course of life cycle at the same time.

As the distinct examples of the characters of many-sidedness, we may take the flagella in the plant kingdom which are two types quite different in construction, the whiplashed type and the tinsel type. In Chlorophyceae there are the one type, the former alone, while in Chrysophyta, Phaeophyta and Diconotomycophyta<sup>2)</sup> we can find two types combined synthetically one to one. The leaf class is clearly belong to the characters of this type and therefore can be coexisted in the same group, even in the same place of an individual.

In the case of leaf class, they consist of often so many individual leaves that the maintenance of the occurrence upon the stem make them own specific rhythmical appearance. If the plant has two classes of leaves, a new and synthetic rhythm is produced by the combination of the two different types of rhythms. These are familiar in many phyllotaxis, and those synthetic examples

2) Maekawa, F.: Journ. Jap. Bot. 21: 115 (1947)



are the very appropriate materials to the analysis of leaf classes.

The life phases<sup>3)</sup> of cells are the good example of the characters of tendency. In Myxomycophyta, amoeboid phase, monadoid phase and cystoid phase are found and changeable to each other in the course of life cycle. The leaf phase may be enumerated as the characters of this type.

Towards the end of this chapter, the writer points out that the ordinary solid concept, in which a leaf treated usually as one unit, is also the obstacle to the new interpretations of the leaves. According to the writer's opinion, a leaf in the ordinary sense, may consist of three or more units of the same leaf class or even not rarely of two different leaf classes. The very common trilacunar leaf traces in angiosperms are often consist of three independent leaves which formally arranged in triphyllously verticillate phyllotaxis and later combined confluent to form a leaf blade consisted of the outer two with the median one (Fig. 2, A and B). Bundles of the leaf in Monocotyledoneae are very likely to be the unit of the leaf class in each.

On the other hand, attention must be paid to the uniform interpretation of the strands in petioles and others, as an independent stele, but it seems to be better in many cases to treat each of them as a meristele or a part which build up together a large bundle as a whole. It seems proper in many cases to interpret the netted veins as the enlargement of the only one vascular bundle, split up into a vast number of meristeles till to make up the anastomosing pattern (Fig. 2, C and D). The writer names this type of expansion of a bundle, as the **crevice formation**. The two discrete strands in the laminal leaf in *Austrobaileya* and the set of inflorescence and a leaf blade in *Ginkgo* may be better interpreted as the results of the crevice formation by means of the relic dichotomy to form a unit bundle as a whole.

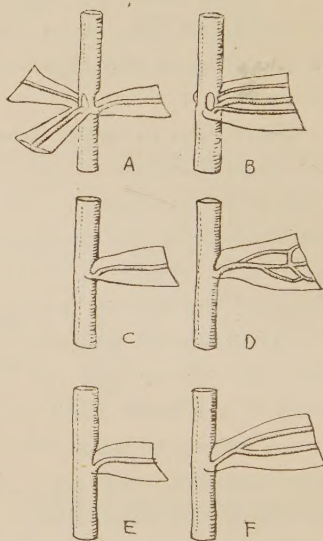


Fig. 2. Examples of leaf blades, which have been derived through, the confluence of three units (A and B), the crevice formation of a bundle (C and D), and the modification of dichotomy (E and F), respectively.

### 3. Kinds of Leaf Class and Leaf Phase

The writer enumerates the kinds of leaf class as follows :

3) Maekawa, F.: Bot. Mag. Tokyo 61: 78 (1948)



Kinds of leaf class groups	Examples
G type group	Inflorescence or so-called flower and laminal leaf of <i>Ginkgo</i> ; Leaf of almost members of leptosporangiate ferns; Leaf of Marattiales; Fertile branch and sterile frond of Ophioglossales; Leaf blade, stamen and carpel of <i>Austrobaileya</i> .
F type group	Laminal leaf of <i>Cyclobalanopsis</i> , <i>Quercus</i> , <i>Carpinus</i> , <i>Betula</i> , and <i>Zelkova</i> ; Laminal leaf of <i>Turpinia</i> , <i>Kandelia</i> , <i>Galium</i> and <i>Adina</i> ; Inflorescence of <i>Cordaites</i> .
E type group	Sporophyll of <i>Equisetum</i> ; Sporangiphore of <i>Lycopodium</i> ; Sporangium and ligule of <i>Selaginella</i> ; Ligule of <i>Isoetes</i> ; Sterile scale and sporophyll of <i>Cordaites</i> .
S type group	Stipules and bud scales of <i>Quercus</i> , <i>Carpinus</i> , <i>Betula</i> and <i>Zelkova</i> ; Interpetiolar stipules of <i>Turpinia</i> , <i>Rhizophora</i> , <i>Adina</i> and <i>Galium</i> ; Leaf sheath of <i>Equisetum</i> ; scales in strobilus of <i>Calamites</i> ; Scales on the leaf of leptosporangiate ferns.

Besides these ones, the following are tentatively enumerated,

D type group	Dicotyledoneae
M type group	Monocotyledoneae
C type group	Cycadariae
A type group	Coniferae

The principal kinds of leaf phase are as follows:

Kinds of leaf phase	Symbols	Examples
cotyledonary phase	ct	cotyledons
scaly phase	sc	scales, scaly leaves
laminal phase	la	blade of foliage leaf
acicular phase	ac	acicular leaf
stipular phase	st	stipule
bracteal phase	br	bract, bractlet, involucre scale
sporogenous phase	sp	spore bearing one
inflorescence phase	fl	inflorescence
male phase	ma	male spore bearing one
female phase	fe	female spore bearing one
calyx phase	ka	calyx
corollal phase	cr	corolla
staminate phase	an	stamen
carpellate phase	cp	carpel
integumental phase	in	integument
rachidial phase	ra	vegetative branch

In the notations, the leaf class is written in capital letter following by a leaf phase in small letters. For example, the inflorescence of *Cordaites* is Ffl, while the laminal leaf of the same plant, Sla. In *Zelkova* the laminal blade may be written as Fla, and stipules of the same are the symbols Sst, and hence the foliage leaf of *Zelkova* can be indicated as Sst Fla Sst.



#### 4. The Establishment of Leaf Class

The writer accepted fundamentally the two kinds of leaves. The one is the cauline origin, derived from the branch through the ancient primitive dichotomy in the main stem. This is also macrophyll and may be called as telom leaf in the other words. In this category, the writer discriminates the two leaf classes, i. e. G and F, both predominate in the higher members of vascular plants.

The other category is the leaf derived from the emergences on the surface of the stem. This is microphyll or in the more accurately called, the emergence leaf, in which the writer includes the two leaf classes, E and S. Generally speaking, telom leaf groups develop well and are larger than the emergence groups.

##### § F leaf class—the case of *Cyclobalanopsis acuta*.

This is one of the two examples, at first investigated by the writer and upon them the basis of the leaf class concept has been established.

*Cyclobalanopsis acuta*, one of the evergreen oaks, common in Japan, has large buds which need a long periods before they open the scales. These

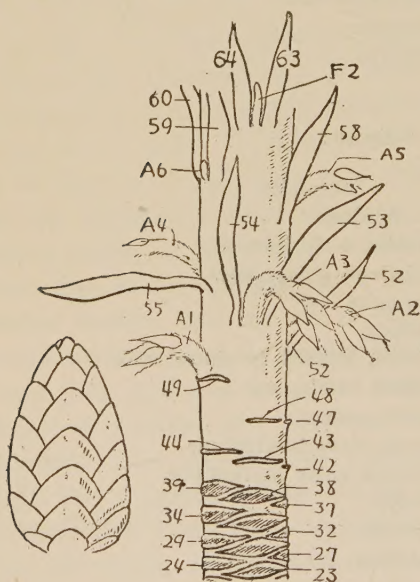


Fig. 3. The bud and the young shoot of *Cyclobalanopsis acuta*, with scales, inflorescences and small protuberances of leaf blade (diagrammatically figured). A1-A6, inflorescences; F1-F2; members of F leaf class, in the form of leaf blade. The numbers of scaly leaves (S leaf class) are enumerated from the second leaf next to prophyll.

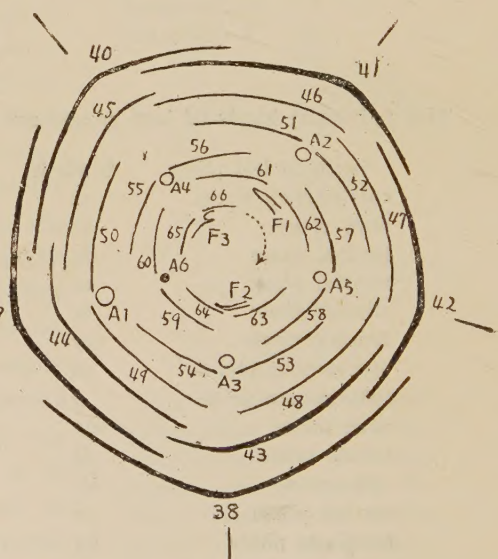


Fig. 4. Diagram of the bud of *Cyclobalanopsis acuta*. Remarks as in the fig. 3.



characters seem to be suitable to examine the leaf arrangements in the bud stage. The bud consists of many imbricated scaly leaves arranged in  $1/5$ -phyllotaxis (Fig. 3, 4 and 5). All those leaves are arranged spirally with aequal distance between them. But in the upper part, there occurs some slight modification in the distance of any two nearest leaves. For example, the distance between 43rd and 44th leaves becomes slightly shorter, while that of 44th and 45th slightly longer, and that of the following two a little shorter than the first case, etc. Therefore, the distance of two leaves is alternately shorter and longer, until in the former case it diminishes to zero, i. e. in the later stage of modification the two which approach nearest at last combined into one set, with longer distance between the two nearest sets. These modification, however, are so continuous that all the leaves can be classified into one kind, what I call S leaf class.

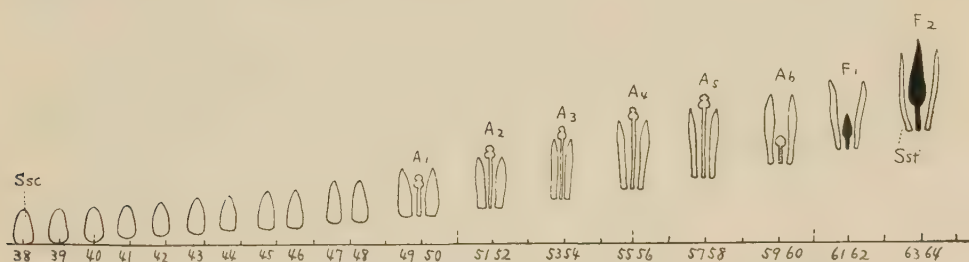


Fig. 5. The arrangement of S and F, showing their gradual transformation and replacement till to the establishment of the combination of SFS. The case of *Cyclobalanopsis acuta*. The remarks as in figs. 3-4.

On the median line between the two members of Ssc in any set, the inflorescence appears rather suddenly. This pattern of insertion of the branch to the main stem is rare and peculiar one in the vascular plants and the only one of the similar example has been previously reported in *Equisetum*, although in which S leaf classes are arranged in a whorl, while in *Cyclobalanopsis*, in the spiral disposition.

The writer wishes to lay stress on this pattern that is quite similar to that of *Cordaites*, in which the short branch i. e. inflorescence is inserted between the two following Sla members upon the main stem (Fig. 6). It is also the remarkable thing to find no laminal leaf near its base.

In the farther part, we can find a small protuberance inserted between two S leaf classes in the set. According as these protuberances

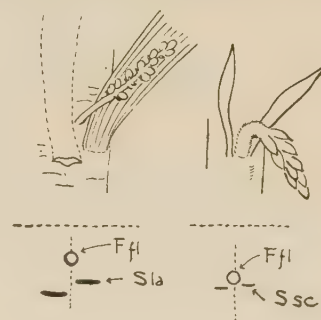


Fig. 6. Similar pattern of the combination between inflorescence and S leaf class. The left, *Cordaites* and the right, *Cyclobalanopsis*.



appear towards the upper end, they look more like normal leaf blades, while the S leaf classes the narrower and finer in texture. The leaf blades are newly originated and come to be inserted between, but are not the transformation of, S leaf class, therefore they may be called F leaf class.

A set SFS has just the same arrangement of a typical leaf with stipules. It is clear these stipules are not the differentiated basal part of a leaf, but just the synthetic result of two different kinds of leaves among which preexisted one is transformed into stipules and is under the influence of newly appeared one. This process of transformation is a new form of stipular origin, which the writer calls synthetic origin of stipules by means of insertion (1949, 1950).

The same pattern of combination between S and F, the writer found in some of

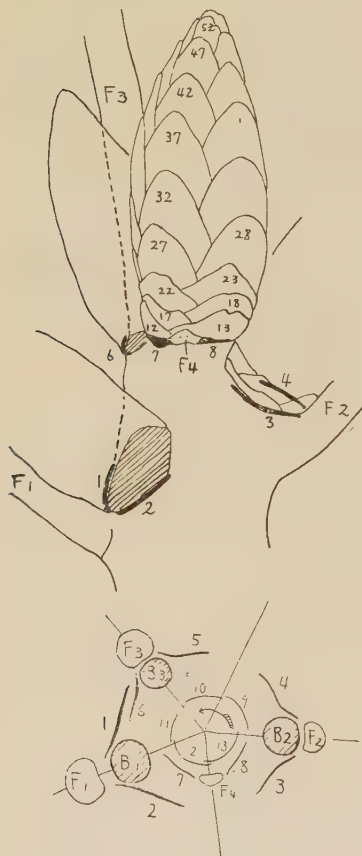


Fig. 7. The phyllotaxis of S leaf class of *Cyclobalanopsis acuta*, from branch to its terminal bud. The numbers begin to enumerate from the left hand stipule of F<sub>1</sub>. Nos. 7 and 8 are the stipules of the undeveloped F<sub>4</sub>, and No. 9 and the remains followed it are arranging on the bud as Ssc. The phyllotaxis is spiral in counter clockwise. F, foliage leaf; B, bud.

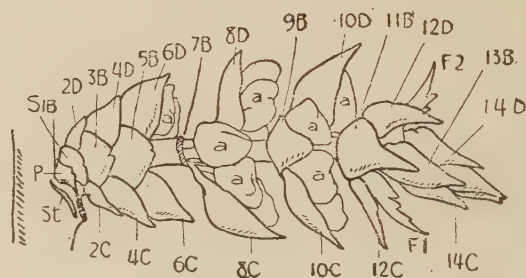


Fig. 8. Lateral view of an unholing axillary bud of *Zelkova serrata*.

The letters of scales (B, C, D and A which does not appear in this figure) indicate the four lines, consisted by the decussate-oriolate pairs of scales. The numerical letters indicate each pair of scales. a, flower; P, prophylls; St, stipules of the leaf belonging to the main stem.

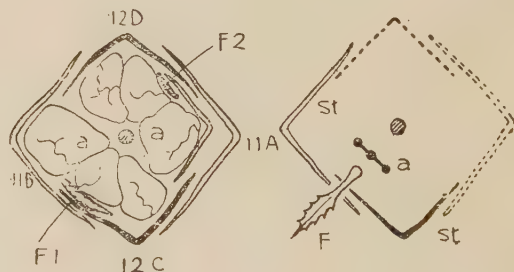


Fig. 9. Diagram of a set of SFS in *Zelkova serrata*.

The letters used are same with those in fig. 8.



the other members of the genus, *Cyclobalanopsis* and *Quercus*, i.e. *C. glauca*, and *Q. phillylaeoides*, although slightly different in some details. In all of them, the phyllotaxis of S leaf class is  $1/5$ , and that of F is  $2/5$ , the combined one is also  $2/5$ .

When the terminal bud appears, this synthetic phyllotaxis returns again to the original  $1/5$  of S leaf class at the top of a branch, where the F disappears to let the S alone again construct a terminal bud (Fig. 7).

In the case of *Zelkova* (Figs. 8, 9 and 10), the bud scales (S leaf class) arrange in opposite-decussate, but towards the upper part, they gradually deform their arrangement. For example, the 8th node in fig. 8 is made of the opposite two S leaf classes (8C and 8D). The members of the set separate each other and as the result of their removal, the one (8C) became nearer to the one member of the next lower stair, 7B, while the other (8D) upwards nearer to the upper next nodal member (9A) and both constitute oblique sets, respectively. Inflorescence of the male flowers are prepared in the median location of each set. This is the similar pattern with that of *Cyclobalanopsis* and *Quercus*. In the farther part, a blade of the F leaf class inserts before the inflorescence, making a set of Sst Fla Sst, just as the same in *Quercus* etc.

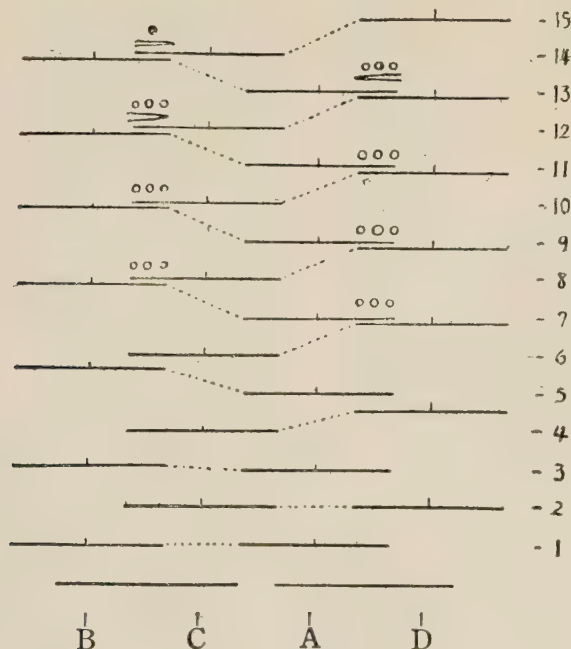


Fig. 10. Diagram of synthetic phyllotaxis of *Zelkova serrata*.

Black line, pairs of decussate-orixate members of S leaf class; folded line, inserted F leaf class; round areas, black and white, flower or flowers, female and male, respectively.

The set of oblique combination, with the half of the members between the nearest two sets of opposite leaves is the origin of stipules and strictly speaking, the stipules are not in pair. *Betula* and *Carpinus* are in the same cases.

While in *Fagus*, although the S leaf class is in opposite-decussate, later in slightly orixate, similar as in *Zelkova*, the insertion of a F leaf class is to the space between the opposite two members of the just the same set. So the

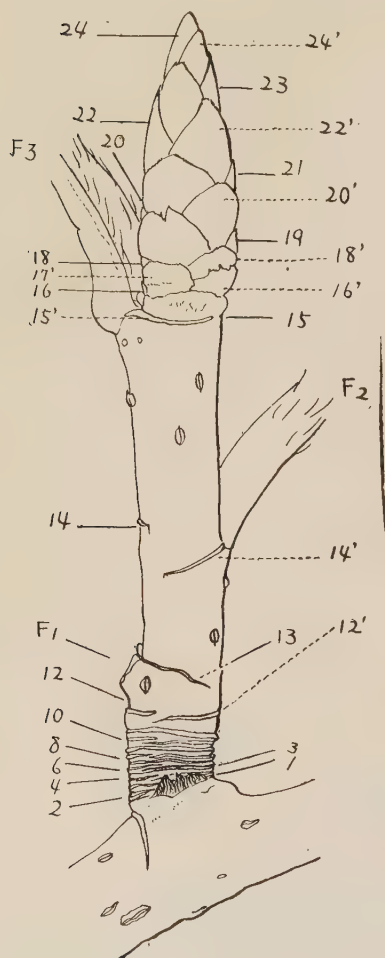


Fig. 11. The phyllotaxis of S leaf class of *Fagus crenata*, from the branch-base to its terminal bud. The number starts from the first scale except prophylls, and indicates paired sets, for example 15 and 15' in a set. All are situated in oppositeorixate phyllotaxis.



Fig. 12. SFSF in *Adina racemosa*, a Rubiaceae species. White semilunar scars are those of F, and greyish transverse lines are the scar of S.



formation of synthetic phyllotaxis is the peculiar that cannot trace by the numerical formula to which the writer calls 'Fagus type' (Fig. 11 and 14, ot).

As the combination of both more primitive phyllotaxis of the two leaf classes, S and F, the writer reported previously the case of Rubiaceae (Fig. 12) and *Turpinia*. Recently another excellent example in Rhizophoraceae (*Kandelia candel*) has been discovered (Fig. 13). These examples are called interpetiolar stipules under the old concept in which the combination of stipules between



Fig. 13. SFSF in *Kandelia candel*. ( $\times$  ca 1.5).

The terminal bud is enveloped by the paired members of S leaf class. Left, the dorsiventral view of S; right, the lateral view of another S, with a F removed.

Table I. Types of combination of S leaf class with F leaf class (Fig. 14).

Types of phyllotaxis of S leaf class	Types of insertion of F to the former	Types of synthetic combination of S with F	Types of construction of a synthetic leaf, or leaves to a node	Phyllotaxis newly acquired of synthetic leaves	Examples	The date investigated	Remarks
opposite- orixate	successive	os	(SFS) SstFlaSst	distichous (1/2)	Ulmaceae <i>Zelkova serrata</i> <i>Hemiptelea Davidiana</i> Betulaceae <i>Carpinus cordata</i> C. <i>Tschonoskii</i>	F. Maekawa 1947 M. Furuya 1949 M. Furuya 1949 F. Maekawa 1949	
triphyllous verticillate	successive	3vs	(SFS) SstFlaSst	alternate (1/3)	Betulaceae <i>Alnus japonica</i>	F. Maekawa 1949	concerned only to three prophylls and the next member of S.
opposite- orixate	twin	ot	(SFS) SstFlaSst	Fagus type	Hamamelidaceae <i>Corylopsis glabrescens</i> Fagaceae <i>Fagus crenata</i> F. <i>Sieboldi</i>	F. Maekawa et M. Furuya 1949 F. Maekawa 1947 F. Maekawa 1947	
opposite	paired twin	ott (combination between opposite SS and opposite FF)	(SFSF) SstFlaSstFla	opposite with interpetiolar stipules	Staphyleaceae <i>Turpinia ternata</i> Rubiaceae <i>Adina racemosa</i> <i>Galium</i> spp. Many other genera of the family. Leguminosae <i>Phaseolus vulgaris</i> <i>Azukia chrysanthos</i> <i>Amphicarpea Edgeworthii</i> <i>Dolichos Lablab</i> <i>Canavalia gradata</i> <i>Vigna sinensis</i>	F. Maekawa 1950 F. Maekawa 1951 F. Maekawa 1950 F. Maekawa 1950 F. Maekawa 1950 F. Maekawa 1951 F. Maekawa 1951 F. Maekawa 1951 F. Maekawa 1951	Leguminosae, Trib. Phaseoleae has a pair of first leaves, in which the SFSF is limited.



opposite	paired-twin	ott'	2(1/2SFl)/2S 2(1/2SstFl) 1/2Sst)	opposite	Leguminosae <i>Pueraria Thunbergiana</i>	<i>Rudua radiatus</i> Rizophoraceae <i>Kandelia candel</i> Urticaceae <i>Urtica Takedana</i>	F. Maekawa 1951 F. Maekawa 1951 F. Maekawa 1952 F. Maekawa 1951	Derived from SF SF, through the split of S.
alternate (1/5)	successive	5as	(SFS) SstFlaSst	quinqu- cials (2/5)	Fagaceae <i>Cyclobalanopsis acuta</i> C. <i>Quercus phillyraeoides</i> Q. <i>crispula</i> <i>Lithocarpus glabra</i>		F. Maekawa 1947 F. Maekawa 1949 F. Maekawa 1949 M. Furuya 1949 M. Furuya 1949	
alternate (1/3)	successive	3as	(SFS) SstFlaSst	primarily alternate in 1/3, later changes to distichous (1/2)	Betulaceae <i>Betula platyphylla</i> B. <i>Ermani</i> B. <i>globispica</i> B. <i>ulmifolia</i> B. <i>dahurica</i>		M. Furuya 1949 M. Furuya 1949 M. Furuya 1949 M. Furuya 1950 M. Furuya 1950	
alternate (1/2)	successive	2-4as	(SFS) SstFlaSst	distichous (1/2)	Fagaceae <i>Castanopsis cuspidata</i> Tiliaceae <i>Tilia europaea</i> Rosaceae <i>Stephanandra incisa</i> Ulmaceae <i>Aphananthe aspera</i> <i>Celtis sinensis</i> <i>Ulmus Davidiana</i> Moraceae <i>Braussonetia papyrifera</i>		F. Maekawa 1949 M. Furuya 1949 M. Furuya 1950 F. Maekawa 1949 F. Maekawa 1949 M. Furuya 1949 F. Maekawa 1949	

that of the opposite foliage leaves was emphasized. But the writer interprets these examples as a combination between opposite SS and opposite FF and the most advanced and specialized one is the case of *Galium* stiples in which two SS developed and divided into exactly similar ones to the Fla.

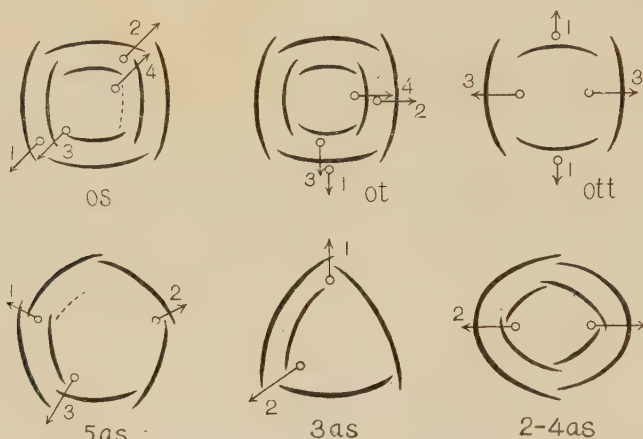


Fig. 14. Several patterns in the synthetic origin of SFS.

Black crescent, members of S; arrow, insertion of F; os, ot, ott, 5as, 3as, and 2-4as are the types of synthetic combination of S with F and all of them may be referred in tab. I.

### § G leaf class—the case of *Ginkgo biloba*.

In 1948, the writer established this concept, G leaf class, on the set of an inflorescence (or flower stalk) and a foliage leaf in *Ginkgo*, which were restricted in the short branch.

There are many scales and foliage leaves on the short branch arranged in the phyllotaxis,  $3/8$  or  $5/13$  (Fig. 15). In the present state, any leaf has no sign of dichotomy in the external morphological relation between the short branch and itself. On the contrary, when we consult with the internal construction, especially with the vascular courses, we can easily find the clear relic of ancient dichotomy not only once but several times repeatedly. The writer named these dichotomies as I, II, III, etc. in serial, which were indicated by the dividing planes between the two homologous units in pairs.

Short branch has an eustelic vascular bundle (A) from which an unit (A') separates externally, leaving a leaf gap of A facing to that of A'. This is the first dichotomy (I), although both A and A' have lost the pattern of the ancient size and form between them. After this separation, A' round up as a holocyclic bundle, immediately followed by the formation of two meristeles (A'<sub>1</sub> and A'<sub>2</sub>), as the result of the second dichotomy (II), in the plane which is perpendicular to the first plane (I). These two dichotomies, (I) and (II) occur in the cortex



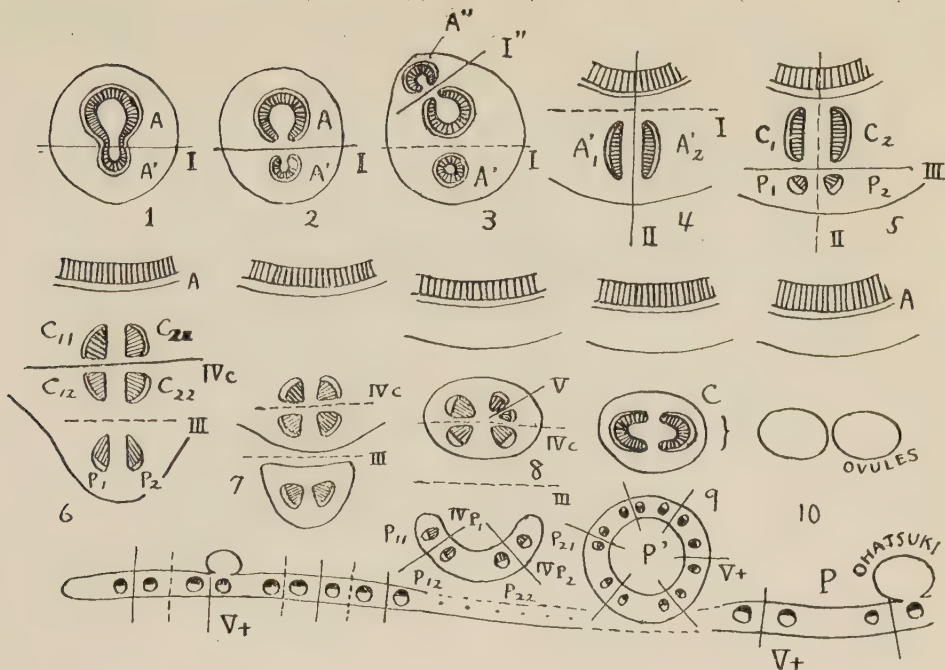


Fig. 15. G leaf class and the dichotomous course of its bundles in the short branch, i.e. the female flower and the leaf in *Ginkgo biloba* (Diagrammatically figured). I, II, III, IV, V and  $V_+$ , dividing planes of dichotomy; A, main stem of short branch; A', G leaf class in common stock; C, G in female flower stalk; P, G in laminal form; P', Gla in infundibular form.

of the branch and even in the third one (III), it is also found in the same area of the branch, and the plane (III) is parallel with the plane of (I), forming  $C_1$  and  $C_2$ , internally and  $P_1$  and  $P_2$  externally from  $A'_1$  and  $A'_2$ , respectively.

After the stage of the third dichotomy (III),  $P_1$  and  $P_2$  remove outwards gradually from  $C_1$  and  $C_2$ , respectively, and at last run into the petiole forming the two bundles within it. On the other hand,  $C_1$  and  $C_2$  divide again dichotomously in the fourth plane ( $IV_c$ ) into the group of  $C_{11}$ ,  $C_{12}$ ,  $C_{21}$  and  $C_{22}$ . These four bundles, which must be treated as meristemes belonging to one stele, usually running upwards parallel to each other, getting away from both the stem and the petiole which is mentioned above, until to form a peduncle or a common stalk of inflorescence (C).

The lamina has many veins, which are derived from the upper ends of the two bundles in the petiole and divided repeatedly forming the usual fan shape expansion (P). But we have some exceptional examples instead of normal fan shape, a more peculiar infundibular shape in various degrees in size and form. (Fig. 16). These examples may be interpreted as an expansion of a stele, in which every meristeme continues to divide repeatedly, keeping the primary

relations as a whole and the writer considers that the infundibular form is the primitive and prior type, which has been changed to the present

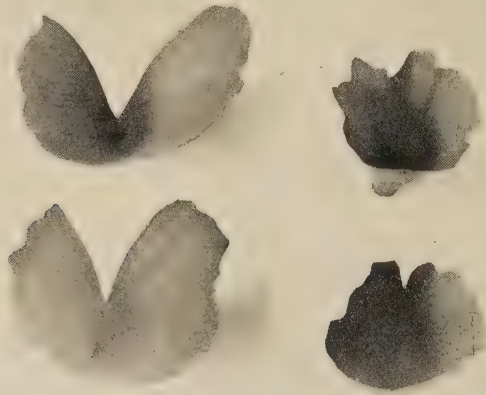


Fig. 16. Infundibular form of G in *Ginkgo biloba*. ( $\times 1$ ).

fan shape by the longitudinal break in the ventral side of the funnel.

It is clear that the above mentioned common peduncle (C) and the leaf petiole (P) are formed as the result of repetition of dichotomy and that both are homologous and belongs to the same leaf class, which the writer named *G leaf class*.

The same pattern of G leaf class may be found in Ophioglossales, especially in some of *Botrychium*, as already reported by Chrysler (1945).

In angiospermous groups, the writer has pointed out the presence of this type, G leaf class, although it is slightly modified, in *Austrobaileya*. The 'discrete two bundles' in a laminal leaf of *Austrobaileya* are homologous to the dichotomous venation in *Ginkgo* leaves (Fig. 17). The difference concerning to their situation of the dichotomy between these two genera, which is found in the lower part of a blade in the case of *Austrobaileya*, in spite of the upper part in *Ginkgo*, is due to the difference

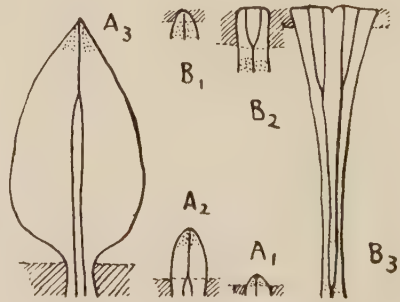


Fig. 17. The affinity in the vascular course of leaves between *Austrobaileya* (A<sub>1</sub>-A<sub>3</sub>) and *Ginkgo* (B<sub>1</sub>-B<sub>3</sub>).

A<sub>1</sub> and B<sub>1</sub> in young stage with a bundle develop into adult blade A<sub>3</sub> and B<sub>3</sub>, respectively through A<sub>2</sub> and B<sub>2</sub>.

Dotted area, primordial area in growth; hatched area, differentiated area in earliest stage in growth.



of their growth form, which is intercalary in the former, while apical in the latter, respectively. Stamens and carpels indicate the secondary fusion between fertile G and sterile G, which may be clear in the figure (Fig. 18).

In the so-called angiospermic sporangium of *Caytoniales*, which often interpreted as the origin of ovary, the outer coat is Gla and the integument, Esp

(Fig. 19). When the reduction takes place in the number of sporangia till to establish the only one in an outer coat, in the evolutionary course of sporangial organ, it seems very natural to treat the fact, as the establishment of a bitegumic ovule, with the outer integument, Gin and the inner, Ein, but

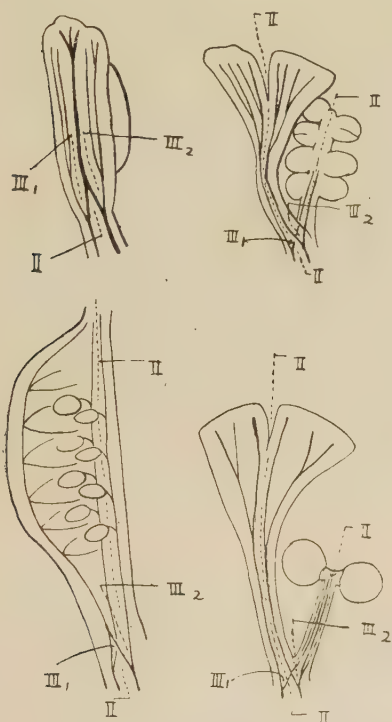


Fig. 18. Affinity in a stamen and staminate flowers with a leaf (upper figures) and in a carpel and pistillate flowers with a leaf (lower figures) of *Austrobaileya* (in the left) and *Ginkgo* (in the right), respectively. I, II, and III, with broken lines indicate the dividing plane of dichotomy.

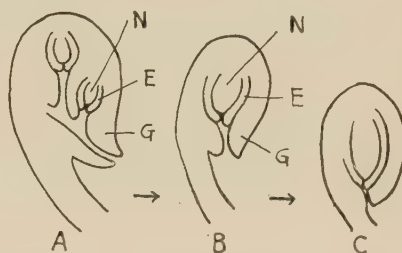


Fig. 19. The evolution of ovule from Caytonian type.

A, the ovule of *Caytonia*, which has several sporangia (N) enclosed in a common leaf blade (G leaf class). E indicates the integument which belongs to E leaf class.

B, intermediate type, introduced by the reduction in numbers of sporangia to one.

C, ordinary anatropous ovule with two integuments, which derived from both leaf blade (G) and indusium (E).

not as that of an uni-ovulate ovary. *Caytoniales* therefore, may not belong to the main ancestral line of angiosperms.

#### § E leaf class and S leaf class.

As already mentioned above, a stem and a terminal sporangium are the most primitive and ancestral form of Cormophyta. When the emergence leaves

differentiate on both stem and sporangium independently, the establishment of the two different leaf classes may take place, i. e. S on the vegetative part, stem, while E on the reproductive part, sporangium (Fig. 20).

In *Calamites*, S extends its area into the reproductive part, where it combines alternately with the member of E, which bears several sporangia. While in *Equisetum*, these two different leaf classes are situated apart from each other. In *Lycopodium*, E bears sporangium and is situated in the median basal part in the adaxial side of the S. While in *Selaginella*, E has a small but distinct laminal part with or without a sporangium and is treated usually as ligule on the leaf (S). *Isoetes* is in the same case.

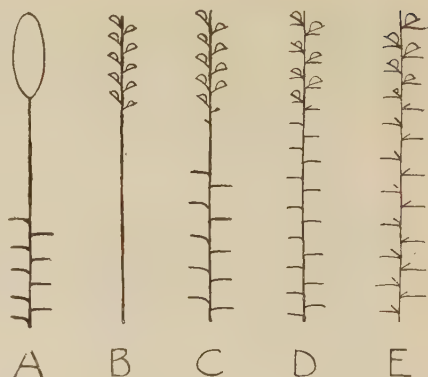


Fig. 20. Several patterns of connection E and S.

A, *Psilophyton*, with S alone; B, *Stigmaphyton*, with Esp alone; C, *Equisetum* with both S and Esp, which have no direct connection to the former; D, *Calamites*, with S and Esp, which directly connected with S; E, *Selaginella* with S and E, all of which connected each other in a set. All are figured in alternate phyllotaxis.

## 5. Phylogenetic Classification of Cormophyta through the Concept of Leaf Class

Under the above-mentioned concept of the leaf class, the considerations will be reasonable to reach the following conclusions.

Vascular plant (Cormophyta) shall be split into two groups, which are phylogenetically quite different to each other.

### 1) Phylum Chlorophyta Subphylum Cormophyta Classis *Stelopsida*.

At first (1), the members of this group have a stem alone, which is dichotomously branched. Then (2), they became to have independently two leaf groups belonging to different classes, E and/or S, the patterns of their phyllotaxis have no relation with branching. Later (3), the inflorescence has removed its situation to the place between the two following members of S and at the same time took the place of the another new class of leaf, F, while the S often degenerates in size to small scaly one. Finally (4), a part of F develops outwards into a foliage-phased F class leaf.

To this class, belong the following subclasses (Fig. 21).

***Psilophytariae*:** A group of the members of most primitive Cormophyta.

Stem dichotomously branched. Sporangia terminal to the stem. Typical



and most primitive ones (for example, Rhyniaceae, Horneaceae) are destitute of both root and any kind of leaf. But some ones, slightly advanced, have primitive S on the almost part of the stem (Psilophytaceae) or the E on the upper part of the stem (Stigmophytonaceae). The more advanced (Baragwanathiaceae) has already the combination in a set between S and E.

Almost the members of this group are extinct. But Psilotales is the only relic among them, which still retains primitive characters, i.e. primitive dichotomous branching in the main stem and no root, but, on the contrary, has the advanced stage in E (the sporangia itself) and in the sympodality of the branches both, sporangiferous and sterile.

.....Psilophytales, Baragwanatiales, Psilotales.

**Isoetariae**: Peculiar inverted stem inside out in its vascular arrangements.

Large S in tuft, each has E (ligule) in the median ventral side. E sometimes has sporangia. Stem has no branch. ....Isoetales.

**Selaginellariae**: Dichotomously branched stem. S is small, formally decussate or secondarily heterophyllously distichous and each has small delicate E in its axil. E is either sporangiferous or sterile.

.....Selaginellales, Lepidodendrales.

**Lycopodiariae**: Dichotomously branching stem. S is small, spirally arranged in formal phyllotaxis. E represented by a sporangium itself.

.....Lycopodiales.

**Equisetariae**: True branching stem. S is small and scaly, whorled in a circle at the node of a stem and connated to a sheath. Spikes are made of one kind leaves, E alone, each having several sporangia, or in some cases, for example as in Calamitales, each E combines with one of S in scaly phase to form a set. The F, as in the branch form (rachidial phase), is often inserted between the two successive members of S, but has never been found either as a foliage phase or in a foliage position.

.....Equisetales, Calamitales.

**Cordaitariae**: Stem has a few branches except the flowering one. S is large in size, parallel veined, and arranged spirally. Flowering stem (F in the inflorescence phase) is inserted on the median line between the two following members of S and, upon it, has many members of the E, which arranged in a single spiral, composed of many sterile ones mixed at intervals with a few fertile. No F leaf class in the foliage phase.

.....Cordaitales.

**Amentiferariae**: Stem with true vegetative branches, situated as axillary to a member of F leaf class. On the stem develop many S, arranging in the two different, patterns reciprocally changeable, in each other. The one phase of S is scaly one in buds, imbricated spirally or in opposite, and the other is the stipular one, in a set at the very base of the insertion of a F

leaf class. The latter has been derived from the former and when, on the top of a branch, any F, does not appear changes again back into the original, i. e. the former pattern. On the whole, F develops well, in the foliage phase but, as an important exception, in the beginning part of an axillary stem, can be found only in the inflorescence phase but never in the foliage one. In the following upper parts several nodes upstairs, they appear in the two patterns, as the inflorescence for inside and the foliage leaf for outside, respectively. On the F of the inflorescence phase, there are many E in scaly or sometimes several in corollal phase.

Urticales and Fagales are the typical members of order rank in this subclass. Hamamelidales, Fabales, Staphyleaceae, Rhizophoraceae, Rubiaceae may be more natural in their taxonomical position when they are put together in this taxon.

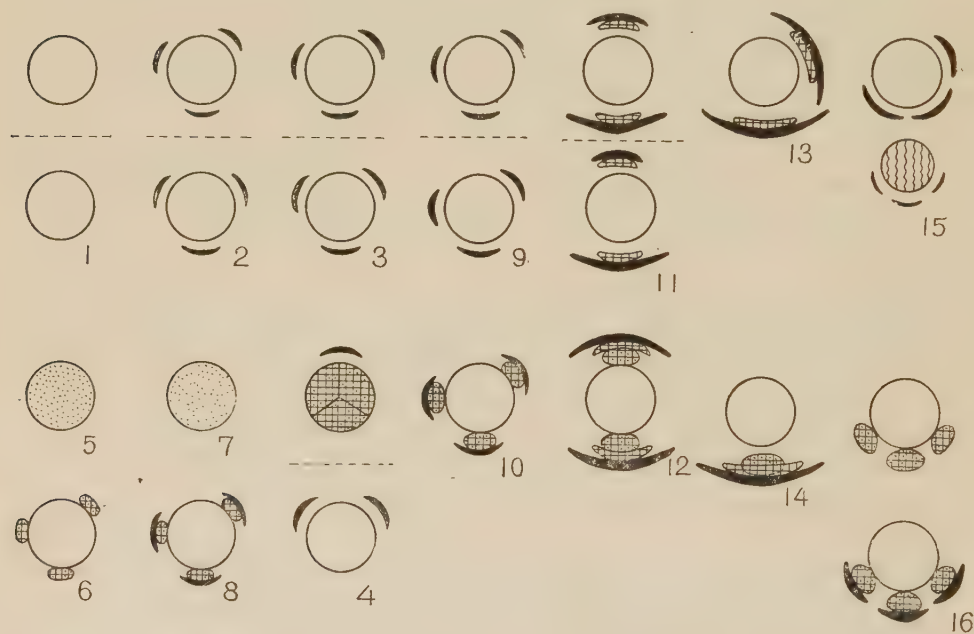


Fig. 21. Diagrams of some groups belonging to Stelopsida.

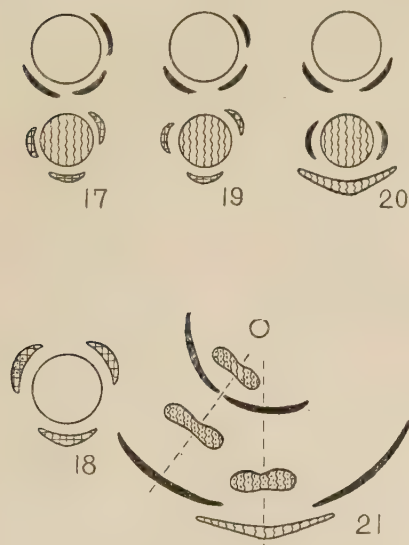
Blank area, stem; black area, S leaf class; latticed area, E leaf class; undulate line area, F leaf class; hatched area, G leaf class; dotted area, sporangiferous area; round area, stem or derived stem; flat or crescent area, various phases of the leaf class, including sporangia figured in ellipse or in alike; upper one or two lines, ramification of vegetative shoot; lower one or two lines, reproductive part; 1 & 5, Rhyniaceae of Psilophytariae; 1 & 6, Stigmaphytonaceae of the same; 2 & 7, Psilophytonaceae of the same; 2 & 8, Baragwanatiaceae of the same; 3 & 4, Psilotales; 9 & 10, Lycopodiariae; 11 & 12, Selaginellariae; 13 & 14, Isoetariae; 15 & 16, Equisetariae; 17 & 18, Cordaitariae; 19 & 20, Amentiferariae; 21, typical flower in Stelopsida.



## 2) Phylum Chlorophyta Subphylum Cormophyta Classis *Phyllopsida*

From the early geological era, they have already had the telom-originated leaf, i. e. G leaf class, which developed and was modified in many ways in the later periods, but have no distinct tendency of the development of both E and S. Sporangia are always found in the margin of, or on the underside of G. Some one gets the dividing tendency in G by the tangential split in it, resulting the sporangiferous G for inside, while the trophophyllous one for outside, respectively. Finally the inside G has postponed the formation of sporangia until it has taken a well developed vegetative part in it and the definite combination between a foliage leaf and an axillary bud, has been established. This combination is much alike but quite analogous to that of stellopsidian pattern.

So far as the present knowledge is concerned, this class has the following subclasses in their area (Fig. 22).



**Protopteridiariae:** This is the starting point of the following group. Stems dichotomously branched, and some of them have displayed the tendency to build up the distinct stem-and-leaf relation among them. Branch-like stem can be treated as the primitive phase of G and bears sporangia on it.  
.....Protopteridiales.

**Filicariae:** Rarely stem in branching. G is, very large and flat, having sporangia in the margin or on the underside. S, often found as scales on the body, or as the aphlebiae on the stem. ....Osmundales, Eufilicales, Marsileales.

**Cycadariae:** Stem rarely branched. G is very large. Sporangia differenti-

ated in male and female and produced in the margin or on the under-surface. S and E lacking. The course of vascular bundle in the G is peculiar in its manner. ....Cycadles, Bennettitales, Caytoniales.

**Marattiariae:** Stem thick but very short in length, also without branch. G large in comparison with the stem, and often has stipules composed of a pair of S. Some one has a set of two G leaves as in *Ophiloglossum*.

.....Marattiales, Ophioglossales, Helminthostachidiales.

**Ginkgoariae:** Stem elongate and has true branching system. In the vegetative part, G of inner side takes the form, of axillary bud, but in the reproductive shoot (short branch), of fertile scape or no trace. The differentia-

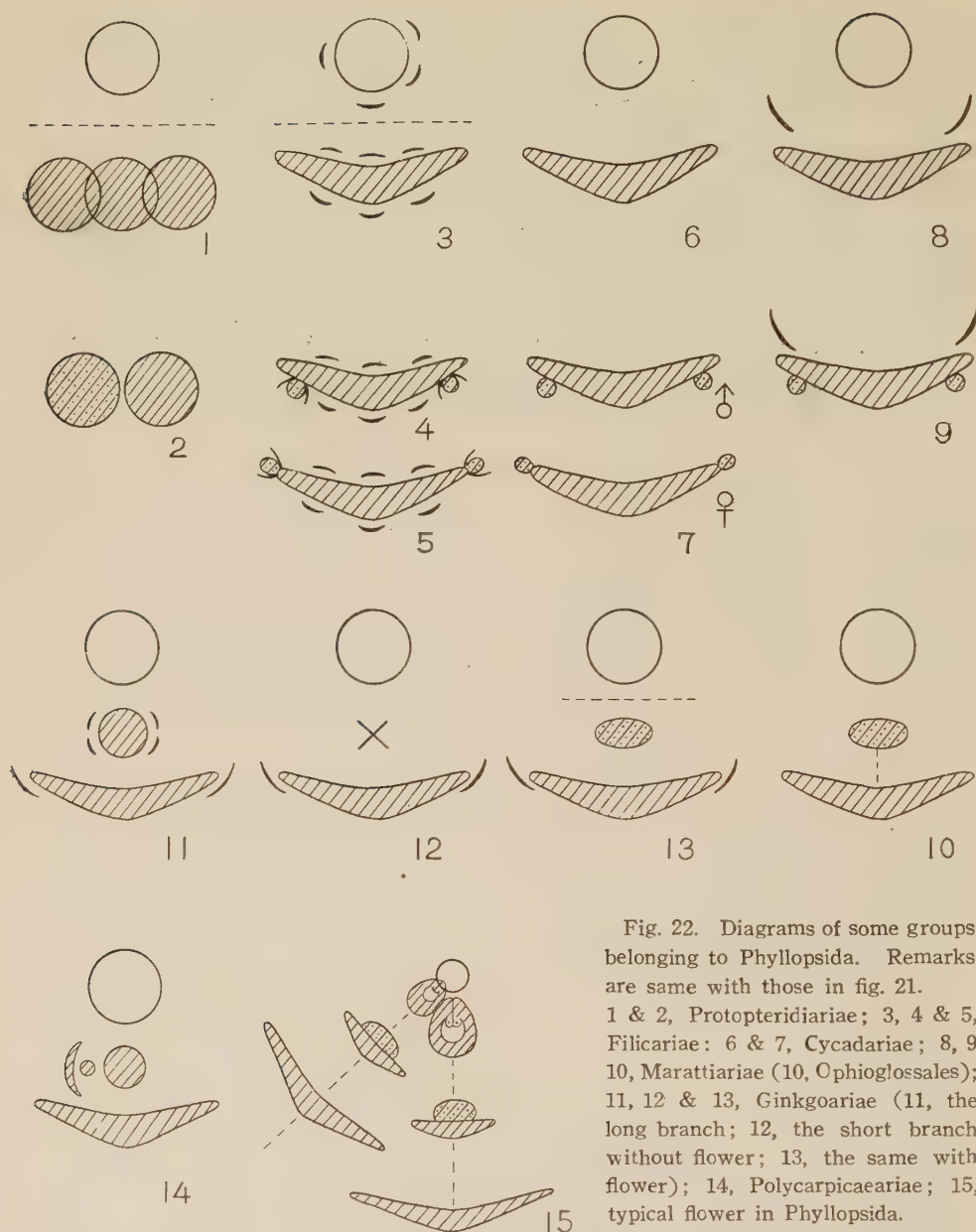


Fig. 22. Diagrams of some groups belonging to Phyllospida. Remarks are same with those in fig. 21.

1 & 2, Protopteridariae; 3, 4 & 5, Filicariae; 6 & 7, Cycadariae; 8, 9, 10, Marattariae (10, Ophioglossales); 11, 12 & 13, Ginkgoariae (11, the long branch; 12, the short branch without flower; 13, the same with flower); 14, Polycarpicaeriae; 15, typical flower in Phyllospida.

tion between the two phases of G is not strict one, as often shown in the ovuliferous habit of the foliage leaf (Ohatsuki phenomena). Members of S are in the form of stipular appendages. .... Ginkgoales.

**Polycarpicariae**: Stem in true branching and in axillary bud formation. G are secondarily differentiated as calyx, petals, stamens, and carpels, respec-



tively. A typical sporangium is protected triply by the E leaf class (inner intergument, indusium), G leaf class (outer intergument) and the other G leaf class (carpel, ovary). .....Magnoliales, Ranales.

The other groups, for examples, Coniferariae, Hydropteridae, Ephedraridae, several trees and herbs in Dicotyledoneae and also Monocotyledoneae etc. are now under study and shall be, not before long, treated in the next papers.

Stelopsida and Phyllopsida are evolved from the common ancestor which had the primary stem, with no branch of dichotomously branching system. The former advanced into the groups under the tendency to have sporangiferous lateral branches (F of inflorescence phase), while the latter, into the one having a broad laminal fronds, often with sporangia on the under-surface (G of laminal and or sporogenous phase) through the metamorphosis of the branches.

The origin of E and/or S can be traced back to the protuberances or emergences upon the surface of a primary stem in the ancestor and are well developed in Stelopsida in various forms and degrees, but less or no in Phyllopsida.

In the course of evolution, these two groups have reached at the similar evolutionary stage, which might be called *the stage of axillary bud formation*, through, on the contrary, a quite different course, respectively (Fig. 23).

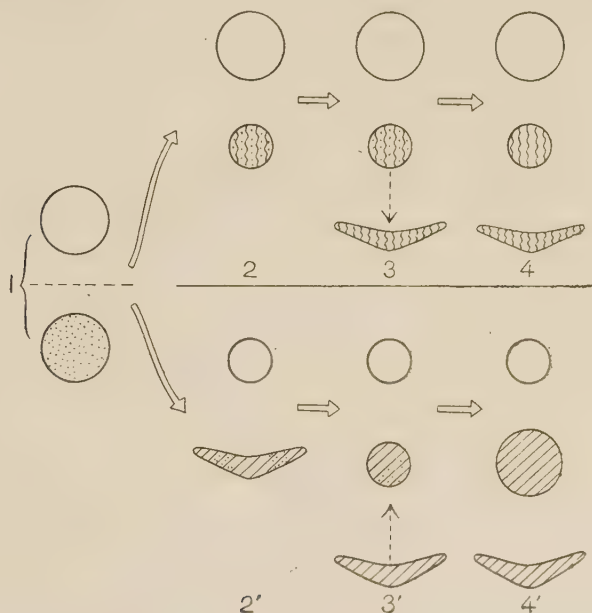


Fig. 23. Two different patterns of axillary bud formation in Stelopsida (upper figures) and Phyllopsida (lower figures).

Stelopsida have got the vegetative axillary bud system, passing through the following three stages.

1) The establishment of an inflorescence as a lateral side branch (the formation of Ffl or Fsp).

2) The outward dividing as a laminal leaf, of the part from the inflorescence branch (the segregation of Fla).

3) The postponement of sporangia formation and the insertion of distinct vegetative part or stem (transformation of Ffl or Fsp to Fra, respectively).

While Phyllopsida has passed the different way, in which the stages could be traced as the following three ones.

1) The establishment of a large laminal leaf (the formation of Gla).

2) The inward formation of a sporangiferous part from the laminal leaf (the segregation of Gfl or Gsp from Gla).

3) The postponement of sporangia formation and the basal insertion of vegetative part in the reproductive portion (the transformation of Gfl or Gsp to Gra, respectively).

It may not be so bold to say about the groups in the following brief sentences, that Stelopsida is a group, developing a leaf outwards from a branch, while phyllopsida is the one, a branch inwards from a leaf.

From this point of view, the writer is strongly inclined to consider that the three groups of vascular plants, i.e. Pteridophyta, Gymnospermae and Angiospermae are not the natural phylogenetic groups, but are merely a series of the evolutionary stages which they had reached and have retained, and that it would be more adequate to treat them as stages, pteridophytic, gymnospermic, and angiospermic, respectively.

### Acknowledgements

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# Contributions to the Study of Variations in the Japanese Plants closely related to those of Europe or North America. Part 1

By

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With 5 Figures in the Text

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## 1. Foreword

The Japanese flora includes many species and genera common to Europe and North America. The disjunct distribution between Japan and eastern North America has been particularly well recognized since Asa Gray first pointed it out in 1846, and various papers dealing with the subject have since been published. The origin of this disjunct distribution is explained by geological and palaeobotanical evidences since the Tertiary period. This does not, however, solve all the problems of the distribution of Japanese plants. Recent careful studies have revealed many interesting additional examples of the relationship between Japanese and European or North American plants, mostly in infraspecific ranks. Recent advances in the field of taxonomy, including phytogeography, cytotaxonomy and experimental taxonomy, demand more detailed study of those plants based on ample specimens and living materials.

This paper is the first attempt to bring together the latest materials on the higher plants of this alliance. I shall analyze and discuss later the phytogeography and origin of the components of the Japanese flora, and the different rates of evolution in different plant groups. Of course this work is in its beginning and many questions are still left unsettled. I should be very grateful if anyone would send me specimens, especially living seeds, of plants from Europe or North America which are treated in this paper.

The dried specimens used for this study are mostly deposited in the Herbarium of the Faculty of Science of the University of Tokyo, the Gray Herbarium of the Harvard University, and my herbarium.

I am much obliged to Emeritus Prof. Takenoshin Nakai under whose direction I began this study, and to the late Prof. M. L. Fernald for his valuable advice during my stay in the Gray Herbarium. My thanks are also due to Prof. Yosito Sinoto and Dr. Tadamasa Miduno (*Ranunculaceae*), who kindly supplied



me cytogenetical data, and to Miss Sachiko Kurosawa who helped me during this work.

## 2. A table of corresponding plants in Japan, Europe and North America

In the following table, the Japanese plants are in the middle column with their scientific name and distribution in Asia, and also other closely allied Asiatic races. The first (left) column indicates the plants from Europe and its adjacent regions, and the last (right) column the North American plants, which are conspecific with or vicarious for the Japanese ones in the middle column.

The opposite brackets [] between localities show a distinct disjunction in the distribution. The chromosome-numbers were added in parenthesis after the locality. Variations, races, and closely allied species in Japan, and the differences between the Japanese plants and the European or North American ones, if any, were reexamined and explained in the accompanied remarks with the citation of important literature.

From this table I have omitted such widely spread weeds as *Polygonum aviculare* L., *Chenopodium album* L., *Portulaca oleracea* L., *Arenaria serpyllifolia* L. var. *tenuior* Mert. et Koch, *Stellaria media* Vill., *Capsella Bursa-pastoris* Medic, *Vicia hirsuta* S.F. Gray, *V. tetrasperma* Schreber, *V. angustifolia* L. var. *segetalis* Koch, *Oxalis corniculata* L., *Euphorbia supina* Rafin., etc. And also arctic plants which are only known from Kuriles or Saghalien in the Japanese Archipelago or those which are found only in Aleutians and Alaska in North America, are not treated. Further monographic studies on critical genera will without doubt reveal many additional examples which should be included in the table.

As regards taxonomic categories, I followed the usage of orthodox taxonomists. I treated as separate species the types which show discontinuous variations in important taxonomical characters and occupy definite geographical areas, even if they easily hybridize each other.

A taxon, subspecies, is used only in the case, in which the two races are distinguished by important taxonomical characters and geographical distribution just like species, but interconnecting forms which cannot be considered as natural hybrids between them, occur in the narrow areas where they touch.

When two geographical races are separated by minor taxonomical characters, I treated them as varieties, and did not regard them as subspecies, avoiding to make too many new combinations under a subspecific rank. Some geographical races are separated only by slight outer morphological characters, and some differentiate also in cytogenetical characters. In many cases, interspecific differences differ from infraspecific ones only in magnitude and degree of complexity.

In taxonomy, I think, all morphological, cytogenetical and physiological

characters and geographical distribution should equally be taken into consideration. In some cases, races evolve in outer morphological characters first without much cytogenetic differences as in *Aquilegia*, and in other cases they are separated for the first by a cytogenetic barrier and do not show much differences in outer morphology. However, the direct introduction of those varied characters, when they are not correlated, into the nomenclature, causes useless confusion.

Such categories in the experimental taxonomy as coenospecies, ecospecies, etc. have a specific meaning of their own, and cytogenetical characters including the sterility boundary give an important clue to classification. By some experimental taxonomists, *Raphanus* and *Brassica* are considered as congeneric, belonging to a single coenospecies, as they hybridize, and also *Aquilegia* is treated as monotypic, because all species of the genus in the orthodox taxonomy which are clearly distinguished by outer morphological characters and occupy separate geographical areas, easily hybridize each other. On the contrary, one observes the case in which an octaploid plant which can be regarded to be derived from a tetraploid one and which is difficult to distinguish from the latter by outer morphological characters, does not hybridize with the tetraploid mother plant.

The taxons in orthodox taxonomy sometimes really fail to tell exact relationships between races, but those in experimental taxonomy also have defects. It is impossible to show the phylogenetic relationship between races by a simple scientific name, and the present nomenclature is a kind of international signs, but it is useful and practical.

I tried to note cytogenetical data on the Japanese plants, but those data at my disposal are poor, and extensive studies on the field are much needed. As to the chromosome-number too, often only one Japanese plant of a species has been examined, so there remains a chance that other races of the same species with different chromosome-numbers may be found by further studies. Many examples will be added in which the Japanese plant identical with the European or North American in outer morphological characters belongs to a different cytotype.

<b>Populus tremula</b> L.	<b>P. tremula</b> .....	<b>P. tremuloides</b> Michaux
Europe, (2n=38, (57, 76)), Caucasus	C. Asia, Siberia, east to Kamt.	Alaska to Labrador, south to Calif., Mexico, Tennessee (mts.) & Virginia (mts.) (2n=38)
	<b>P. Davidiana</b> Dode	
	Amur, Ussuri, Manch., n. China, Korea, Saghal., s. Kuril., Yezo	
	<b>P. Sieboldi</b> Miq.	
	Yezo, Honshu, Shikoku, Kyushu (2n=38)	

Lit. Hultén, Fl. Kamt. 2:4 (1928), Fl. Alaska 3:496 (1943); A. Kimura in Miyabe et Kudo, Fl. Hokk. & Saghal. 4:391 (1934).

<b>Salix amygdalina</b> L. ....	<b>S. subfragilis</b> Anders. ....	<b>S. amygdaloides</b> Anders.
( <i>S. triandra</i> L.)	( <i>S. amygdalina</i> var. <i>nipponica</i> (Fr. et Sav.) Schneid.)	British Columbia to Quebec, south to Oregon, Utah, Indiana & New York
Europe (2n=38, (44)),	Ussuri, Manch., n. China, Korea,	
Caucasus, C. Asia,	Saghal., Yezo, Honshu, Shikoku,	
Iran, Siberia	Kyushu	

Lit. A. Kimura in Miyabe et Kudo, Fl. Hokk. & Saghal. 4:398 (1934), in Acta Phytotax. et Geobot. 13:184 (1943).

<b>Myrica Gale</b> L. -----	<b>M. Gale</b> —	<b>M. Gale</b>
Europe (Norway to	var. <b>tomentosa</b> C. DC.	var. <i>tomentosa</i>
Ladoga distr., south	( <i>Gale japonica</i> Chev.)	Alaska to Washington, Oregon
to Portugal & Baltic	[Ochotsk, Ussuri, s. Kamt., Saghal.,	<b>M. Gale</b> & var.
States) (2n=48)]	s. Kuril., Yezo, n. & c. Honshu	<b>subglabra</b> (Chev.) Fernald
	(rare)	Great Bear Lake, Brit. Columbia to Labrador, south to Minn., e. Pennsylv. & Tenn., N. Carolina. (mts.)

The Eastern Asiatic plants are distinguished from the European in having broader densely pubescent leaves with the obtuse apex. The shape and number of serration and the hairiness on the midrib of leaves are very variable, and the extreme form, *Gale japonica*, is connected to var. *tomentosa* by many intermediate forms, and the Japanese plants together with those from Ussuri, Kamtchatka, and Alaska belong to the single geographical race of *M. Gale*.

Lit. Chevalier, Monogr. Myrica. 92 (1901); Hultén, Fl. Kamt. 2:22 (1928), Fl. Alaska 4:571 (1944); Miyabe et Kudo, Fl. Hokk. & Saghal. 4:453 (1934); Hara in Bot. Mag. Tokyo 64:76, map 3 (1951).

<b>Alnus crispa</b> (Ait.) Pursh	— <b>A. crispa</b> —	— <b>A. crispa</b>
	( <i>A. fruticosa</i> Rupr.)	Alaska to Labrador, south to n. Calif., Minn. & N. Carolina (mts.) (2n=28); s. Greenland
e. n. Russia, Siberia (east to Amur, Ochotsk, n. Kamt., Chukch), n. Mongolia, Saghal.	subsp. <b>mandshurica</b> (Call.)	subsp. <b>sinuata</b> (Regel) Hultén
<b>A. viridis</b> (Chaix) DC.	subsp. <b>Maximowiczii</b> (Call.)	( <i>A. sinuata</i> Rydb.)
c. Europe (2n=28)	Amur, Ussuri, Manch., n. Korea	Kamt.?, e. Aleut., Alaska to Oregon, n. Calif., east to Montana
	Hultén ( <i>A. Maximowiczii</i> Call.)	
	Ussuri, Korea, s. Saghal., Kamt.?, Kuril., Yezo, n. & c. Honshu (mts.)	

The Japanese plants, although variable in the size and texture of leaves and the size of cones (8–20 (–25) mm long), belong, in my opinion, to a single geographical race, subsp. *Maximowiczii*. They show a clear tendency to have broad leaves which are abruptly acuminate at the apex, and often cordate at the base, and have long apiculate teeth on the margin. A few specimens from Yezo show a tendency to a slight lobation of leaves, but they cannot be referred to the American subsp. *sinuata*. I have examined also a specimen of subsp. *Maximowiczii* from Is. Shikotan of Kuriles which has pubescent branches and leaves.



But the situations are not so simple in Kamtchatka, Saghalien, Ussuri, Manchuria and Korea, where two or more races meet. In northern Saghalien, intermediate forms which have broader leaves than the typical *A. crispa*, and which have leaves with roundish bases and less pointed teeth compared with subsp. *Maximowiczii*, are often found, and also a pubescent form<sup>1)</sup> which resembles very closely *A. crispa* var. *mollis* Fernald, occurs in the northern and central districts of Saghalien. Some among a series of similar intermediate forms, were named by Callier as var. *kamtschatica* and var. *mandshurica*.

Lit. Callier in Mitt. Deuts. Dendr. Ges. 1918: 39; Miyabe et Kudo, Fl. Hokk. & Saghal. 4: 472 (1934); Hultén, Fl. Kamt. 2: 34 (1928), Fl. Alaska 4: 586 (1944).

**Betula pendula** Roth.....**B. platyphylla** Sukatchev.....**B. kenaica** Evans  
(*B. verrucosa* Ehrh.) e. Siberia (Dahuria, Jakutsk, Alaska (2n=70), n. w.  
Europe (2n=28, (42)), Amur) Canada  
Siberia (east to Altai), with var. **japonica** (Miq.) Hara  
var. *lapponica*, var. *saxatilis* Ussuri?, Korea, Saghal., Kamt.,  
and var. *truncata*. Kuriles, Yezo, n. & c. Honshu (2n=28)  
var. **kamtschatica** (Reg.) Hara  
Ussuri, Saghal., Kamt., Kuril.,  
Yezo, Honshu ?  
var. **mandshurica** (Reg.)  
Hara  
n. China, Manch., Ussuri, Korea,  
Saghal., Yezo, c. Honshu (rare)  
var. **szechuanica** (Schn.) Rehd.  
w. China

**B. populifolia** Marsh.  
s. Ontario to Nova Scotia,  
south to n. Indiana and  
Virginia (mts.) (2n=28)



Fig. 1. *Betula platyphylla*  
var. *japonica* Hara.  
Samara:  $\times$  ca. 4.

The Japanese white birch has smooth beautiful white barks as if painted, leaves which are truncate to slightly cordate at the base, long caudately acuminate at the apex and thinly hairy especially in the axils of nerves and resiniferous glandular beneath, thick catkins, broader catkin scales, samarae 4-5 mm wide including broad wings, and wings of samarae often twice as broad as nutlets (Fig. 1).

*B. kenaica* of Alaska is clearly separable from the Japanese white birch by exfoliate brownish gray barks, leaves less pointed at the apex and less hairy, thinner catkins, smaller catkin-scales, samarae 2-3 mm wide including wings, wings of samarae as broad as or narrower than nutlets, and a high chromosome-number.

*B. platyphylla* of Dahuria and Jakutsk differs from the Japanese white birch by its leaves which are glabrous in the axils of veins and less glandular beneath, but agrees well with the latter in smooth white barks, the shape of leaves (with truncate base and long pointed apex), thick catkins, and samarae

1) *Alnus crispa* var. *sachalinensis* (Koidz.) Hara, comb. nov.

*A. fruticosa* var. *sachalinensis* Koidzumi in Bot. Mag. Tokyo 27: 144 (1913).

with large and broad wings. Thus it is apparent that the Japanese white birch is nearer to *B. platyphylla* than *B. kenaica*, and if it is united with *B. kenaica* as Lindquist did, then they should be all included under a polymorphic *B. pendula* as subspecies.

In Eastern Asia, some different races which are very near to the Japanese white birch are present. Var. *kamtschatica* has leaves often less hairy and not long pointed, and wings of samarae slightly narrower, and var. *mandshurica* has less hairy leaves with truncate to broad cuneate bases, thinner catkins, smaller catkin-scales, and narrower wings of samarae. The plant of Shansi illustrated by Lindquist (1947) as *B. kenaica* var. *japonica* probably belongs to var. *mandshurica*, and is not the typical Japanese white birch.

Lit. Hultén, Fl. Kamt. 2: 32 (1928), Fl. Alaska 4: 576 (1944); Hara in Journ. Jap. Bot. 13: 383 (1937), 25: 203 (1950); Rehder in Journ. Arnold Arb. 19: 72 (1938), 20: 410 (1939); Lindquist in Svensk Bot. Tidskr. 41: 45 (1947).

<b>Humulus Lupulus</b> L. - - - - -	<i>H. Lupulus</i> - - - - -	<i>H. Lupulus</i>
c. & s. Europe (2n=20),	var. <b>cordifolius</b> Maxim.	[Montana to New Brun-
Caucasus, Asia Minor, C.	( <i>H. cordifolius</i> Miq.)	wick, south to New Mexico,
Asia, s. w. Siberia]	[China, Saghal., Yezo, n. & c.	Missouri & Pennsylv.
	Honshu (2n=20)]	

Var. *cordifolius* is hardly separable from *H. Lupulus* by outer morphological characters, but has different flavour and cannot be used for brewing beer. The chromosome-number is the same in both races, but the sex-chromosomes of *H. Lupulus* seem to be XY-type and those of var. *cordifolius* are XXXY-type.

<b>Viscum album</b> L. - - - - -	<i>V. album</i>
Europe (2n=20), Caucasus,	var. <b>rubro-aurantiacum</b> Makino
Asia Minor, Persia, Himalaya,	(subsp. <i>coloratum</i> Komarov,
Tibet	<i>V. coloratum</i> Nakai)
	Burma?, China, Manch., Amur, Ussuri,
	Korea, Yezo, Honshu, Shikoku, Kyushu,
	Formosa

In Japan, this species is parasitic only on deciduous broad-leaved trees, especially on those belonging to Ulmaceae and Fagaceae. The berries are always yellowish<sup>2)</sup> or reddish-orange, and never white in Eastern Asia.

<b>Bistorta major</b> S. F. Gray	— <i>B. major</i> (In a wide sense)
( <i>Polygonum Bistorta</i> L.)	Siberia (east to Ussuri, Ochotsk, s.
c. & s. Europe (2n=44, 46),	Kamt.), China, Manch., Korea, Saghal.,
Caucasus, Asia Minor, C. Asia,	Yezo, Honshu, Shikoku, Kyushu
Himalaya	subsp. <b>plumosa</b> (Small) Hara
	( <i>Polyg. ellipticum</i> Willd., p. p.)
	Siberia (Lena to Chukch, south to
	Ochotsk & c. Kamt.)
	subsp. <i>plumosa</i>
	( <i>P. plumosum</i>
	Small)
	Alaska to n.
	Mackenzie

- 2) *Viscum album* var. *rubro-aurantiacum* f. *lutescens* (Makino) Hara, comb. nov.  
*V. album* var. *lutescens* Makino in Bot. Mag. Tokyo 25: 17 (1911).

The group of *Bistorta major* is particularly polymorphic in Eastern Asia, and requires critical studies based on ample materials. All Japanese forms, I think, should be treated as varieties of European *B. major*, but it is difficult to decide correct varietal names for them until Siberian forms are cleared up.

The ordinary form in Europe has generally oblong-ovate acute leaves which are more or less papillose-pubescent beneath, thick spikes with rose flowers 3.5–4 mm long, abruptly pointed ochreae with a long aristate tip, and seeds 4–4.5 mm long. While a common form in Honshu, var. *japonica* Hara<sup>3)</sup>, has elongate glabrous leaves long-tapering to the top, slender spikes with smaller whitish flowers 3–3.5 mm long, ochreae with a short tip or gradually narrowed to the top, and smaller seeds 3–3.5 mm long. Japanese specimens, however, are variable and often approach to the European in some of the characters above mentioned, but no Japanese specimen exactly agrees with the European.

A form which is very near to the European, var. *ovata* (Nakai) Hara, with broad leaves and thick spikes, is found on high mountains of Yezo and north & central Honshu, and var. *ussuriensis* (Regel) Hara seems to be a similar form. Some specimens from north Yezo and Saghalien which have thicker coriaceous leaves with distinct veinlets may be referable to var. *pacifica* (Petrov) Hara.

In western Japan, especially in Shikoku and Kyushu, and also Quelpaert, another form with long and narrow lanceolate leaves occurs, and it belongs to the group which includes *Polygonum sinomontanum* Sam. ex Hand.-Mzt., *P. alopecuroides* Turcz. and *Bistorta lapidosa* Kitagawa.

Plants with leaves papillose-pubescent beneath are uncommon in Japan, but are found both in broad-leaved and narrow-leaved forms.

Lit. Komarov in Not. Syst. Herb. Hort. Petrop. 6: 2 (1926); Grigorjev in Flora URSS. 5: 672 (1936); Hara in Journ. Jap. Bot. 13: 381 (1937); Nakai in Journ. Jap. Bot. 14: 734 (1938).

<i>Bistorta vivipara</i>	<i>B. vivipara</i>	<i>B. vivipara</i>
(L.) S. F. Gray	Asia Minor, C. Asia, Siberia (east to	Aleut., Alaska, arctic Cana-
( <i>Polygonum viviparum</i>	Ussuri, Ochotsk, Kamt., Chukch) (2n	da, to Labrador, south to
L.)	= 83–88), Himaalya, Mongolia, China,	Oregon, New Mexico,
Europe (2n = ca. 100,	Manch., n. Korea, Saghal., Kuriles, Yezo,	Minn. & New England
110, 132), Caucasus	n. & c. Honshu (alp.)	(mts.); Greenland

Although Japanese specimens are variable including a robust tall form, some agree well with the European. A form with leaves papillose-pilose beneath

3) *Bistorta major* var. *japonica* Hara, var. nov.

*Polygonum Bistorta* var. *japonicum* Hara.

Caulis elatus. Folia vulgo lanceolata e basi ad apicem longe gradatim attenuata glabra, caulina media 10–20 cm longa 1.5–3 cm lata. Flores 3–3.5 mm longi. Achenia 3–3.5 mm longa.

Typus. Honshu: Nikko, prov. Shimotsuke (Matsumura in Herb. Univ. Tokyo).



rarely occurs also in central Honshu, north Korea and Manchuria. It is remarkable that this species with viviparous bulbs has high and variable chromosome-numbers.

Lit. F. Maekawa in Journ. Jap. Bot. 11: 672 (1935); Nakai in Journ. Jap. Bot. 14: 739 (1938); Hultén, Fl. Alaska 4: 620 (1944).

<i>Oxyria digyna</i> (L.) Hill	<i>O. digyna</i>	<i>O. digyna</i>
Europe (2n=14), Caucasus, Asia Minor, C. Asia	Siberia (arctic & Sajan, Ochotsk, Kamt.), Himalaya, Mongolia, w. China, n. Korea, Saghal., Kuril., Yezo (alp.), c. Honshu (alp.) (2n=14)	Alaska, arctic Canada to Labrador, south to Calif., Arizona, Newfld., Quebec, New Hampshire (mts.); Greenland

<i>Persicaria amphibia</i>	<i>P. amphibia</i>	<i>P. amphibia</i>
(L.) S. F. Gray ( <i>Polygonum amphibium</i> L.)	var. <i>amurensis</i> (Korsh.) Hara <sup>4)</sup>	var. <i>stipulacea</i> (Coleman) Hara <sup>5)</sup>
Europe (2n=ca.66), Asia Minor, n. Africa	Siberia (east to Ussuri, Kamt.), Persia?, Himalaya, n. China, Mongol., Manch., Korea, Saghal., Kuril., Yezo, n. & c. Honshu (rare)	( <i>Polyg. amphibium</i> subsp. <i>laevimarginatum</i> Hult.) Alaska to Labrador, south to Calif., Colorado & New Jersey; S. America

The Japanese plant has elongate floating leaves with the cordate base and the smooth margin except for a transitional form to a terrestrial one, and spikes 1-1.5 cm thick. The terrestrial form is rare in Japan and its leaves are pubescent with short stiff appressed hairs on both surfaces and the margin. I here treated of the Japanese plant which is identical with plants from Saghalien, Amur and Ussuri, as var. *amurensis* which shows somewhat intermediate characters between European and American plants.

In Korea, Manchuria and Mongolia, the terrestrial form is not uncommon, and floating leaves are often rounded at the base. I am not certain if all plants with smooth leaf-margin, belong to a single race or not.

Lit. Stanford in Rhodora 27: 109, 125, 146, 156 (1925); Hultén, Fl. Alaska 4: 612 (1944); Fernald in Rhodora 48: 49 (1946).

<i>Persicaria Hydropiper</i> (L.) Spach	<i>P. Hydropiper</i>
( <i>Polygonum Hydropiper</i> L.)	C. Asia, Siberia (east to Amur, Ussuri), Asia Minor, India, Malaya, China, Manch., Korea, Saghal., Yezo south to Formosa
Europe (2n=20), Caucasus, n. Africa	var. <i>scabrida</i> Hara Korea, Honshu, Shikoku, Kyushu, Formosa, Bonin, etc.

4) *Persicaria amphibia* (L.) S. F. Gray var. *amurensis* (Korsh.) Hara, comb. nov.  
*Polygonum amphibium* var. *amurense* Korshinsky in Act. Hort. Petrop. 12: 382 (1892). *Persicaria amurensis* Nieuwland in Amer. Midl. Nat. 2: 183 (1912).

5) *Persicaria amphibia* var. *stipulacea* (Coleman) Hara, comb. nov.  
*Polyg. amphibium* var. *stipulaceum* Coleman, Cat. Fl. Pl. S. Pen. Mich. 32 (1874).

In Japan this species is very variable, and there occur several races which are not found in Europe.

Var. *scabrida* Hara has leaves appressed strigose-hairy on the midrib, sub-compact ochreae with ciliae 3-7 mm long, ciliolate ochreolae, and lenticular ovate-rounded achenes about 2 mm long. It is connected through intermediate forms with the European race which has glabrous leaves and ochreae, and larger achenes, and interconnecting forms are found in eastern and southern Asia with both extremes.

It is also remarkable that various horticultural forms of this species such as var. *fastigiata* (Mak.), var. *graminea* (Meisn.) Ohwi, var. *laetevirens* (Makino) Nemoto, var. *Maximowiczii* (Regel) Nemoto, etc. are in cultivation in Eastern Asia; their seedlings and young leaves are used as spice for their special acrid taste.

Lit. Hara in Journ. Jap. Bot. 14: 73 (1938).

<i>Persicaria lapathifolia</i>	<i>P. lapathifolia</i>	<i>P. lapathifolia</i>
(L.) S. F. Gray	( <i>P. tenuiflora</i> (Presl.) Hara)	British Columbia to Newfld.,
( <i>Polygonum lapathifolium</i> L.,	Caucasus, Asia Minor, s.	south to Mexico
<i>P. nodosum</i> Pers. p. p.)	Siberia (east to Amur, Us-	
Europe (2n=22, 44); Africa	suri), India, Malaya, China,	
	Manch., Korea, Saghal., Yezo,	
	south to Formosa (2n=22)	

This is a very polymorphic species widely growing in the temperate region.

*Persicaria tomentosa* (Schrank) Bicknell (*Polygonum tomentosum* Schrank, *P. scabrum* Moench, *Persicaria lapathifolia* auct. jap.) with larger achenes about 3 mm long is also found in cultivated fields of Japan.

Lit. Fernald in Rhodora 23: 258 (1921); Danser in Rec. Trav. Bot. Néerl. 18: 125, t. 1-3 (1921); Trigoyen et Thellung in Viertel. Nat. Ges. Zürich. 74: 244, t. 1-9a (1929); Britton in Journ. Bot. 71: 94 (1933).

<i>Persicaria sagittata</i>	<i>P. sagittata</i> (L.) H. Gross
var. <i>sibirica</i> (Meisn.) Miyabe &	( <i>Polygonum sagittatum</i> L.)
var. <i>Sieboldi</i> (Meisn.) Nakai	Saskatchewan to Newfld., south
( <i>P. Sieboldi</i> (Meisn.) Ohki)	to Texas & Florida
s. Siberia (Tomsk, Altai to Amur, Ussuri),	
Manch., China, Mongolia, Korea, Saghal.,	
s. Kuril., Yezo, Honshu, Shikoku, Kyushu,	
Formosa (2n=34)	

I have examined ample materials both from Eastern Asia and eastern North America, but could not find stable characters to separate specifically two plants in the disjunct areas. The shape and arrangement of prickles and the nature of the surface of seeds are variable. The only constant character in the Eastern Asiatic plant is that the leaf-margin is always smooth, while in the American one, leaves have bristles on the margin especially those in the lower part of stems, although specimens with smooth margin can be found very rarely in North America.

The plant from East Siberia called *Polyg. sagittatum* var. *sibiricum* Meisn., var. *paludosum* Komarov, and *P. belophyllum* Litwinov are a poor form which is often found in northern marshes and which probably does not deserve to be recognized even as a variety. It has slender stems with smaller & fewer prickles, smaller leaves, fewer-flowered inflorescences, and slightly smaller flowers, and I found the same form also in Yezo, central Honshu, south Kuriles, and Korea. The common Japanese form, var. **Sieboldi**, is more robust and branched with many retrorse prickles on stems and three rows on petioles, but petioles in the upper part of the stem have often only one row of prickles or they are smooth.

Sometimes a form<sup>6)</sup> which has leaves sparsely hairy above and strigose on the margin, is found in Saghalien, Yezo and Honshu, and is confounded with the American plant. An extreme form<sup>7)</sup> with leaves densely hairy on both sides is rarely met with in central Honshu.

If the Asiatic plant is taken as a separate species, the correct specific name is *Pers. Sieboldi* Ohki based on *Polyg. Sieboldi* Meisner (1857), as the earlier name, *Polyg. Sieboldii* Reinwardt ex De Vriese was published only as a synonym of *Polyg. cuspidatum* from 1849 to 1852.

Lit. Miyabe et Kudo, Fl. Hokkaido & Saghal. 4: 519 (1934); Koidzumi in Acta Phy. & Geobot. 8: 51 (1939); Honda in Bot. Mag. Tokyo 53: 383 (1939).

**Rumex Acetosa** L. ————— *R. Acetosa*

Europe (2n = ♀ 14, ♂ 15),	Caucasus, C. Asia, Siberia (east to Amur,
Africa (nat. ?)	Ochotsk), Asia Minor, Himalaya, China,
	Manch., Korea, Saghal., s. Kuril., Yezo,
	Honshu to Formosa, Australia (nat. ?)

The Japanese plants have lacerated ochreae, fruiting valves 3-5 mm wide, and lustrous black-brown seeds 1.7-2 mm long. They are often growing along dikes of rice-field, and may at least be partly introduced.

The common Japanese plant has chromosomes, (2n = ♀ 12+2X, ♂ 12+X+2Y), and intersexual plants with triploid (18+2X+2Y), (18+3X), and tetraploid (24+3X+2Y) chromosome are also found in Japan.

Lit. Löve in Bot. Notis. 1944: 239 (1944); Reehinger f. in Candollea 12: 24 (1949).

**Rumex arifolius** Allioni (1774) ————— *R. arifolius*

(*R. montanus* Desf., *R. Acetosa* subsp. *alpestris* (Scop.) Löve)  
 Europe (2n = ♀ 14, ♂ 15), Caucasus, Siberia (east in Ochotsk, Kamt.,  
 Chukch), Saghal., Kuril., n. Korea, Yezo,  
 n. & c. Honshu (high mts.) (2n = ♀  
 12+2X, ♂ 12+X+2Y)

6) *Persicaria sagittata* H. Gross var. *Sieboldi* (Meisn.) Nakai  
 f. **pilosa** (Hara) Hara, comb. nov.—*Pers. Sieboldi* f. *pilosa* Hara in Journ. Jap. Bot.  
 9: 126 (1933); in Bot. Mag. Tokyo 48: 893 (1934).

7) f. **tomentosa** (Hara) Hara, comb. nov.—*Pers. Sieboldi* var. *tomentosa* Hara in Journ.  
 Jap. Bot. 9: 125 (1933).



The Japanese plants have broad leaves, entire ochreae, fruiting valves 3.5-4.5 mm wide, and shining black-brown seeds ca. 2.5 mm long.

<b>Rumex crispus</b> L. ....	<b>R. japonicus</b> Meisn.
Europe (2n=60), Caucasus, Asia	( <i>R. crispus</i> var. <i>japonicus</i> (Meisn.) Makino)
Minor, C. Asia, Iran, China	China, Korea, Saghal., Kuril., Yezo, Honshu,
(nat.?)	Shikoku, Kyushu, Formosa

*Rumex crispus* L. and also *R. longifolius* DC. (*R. domesticus* Hartm.), *R. maritimus* L., *R. aquaticus* L., *R. obtusifolius* L. subsp. *agrestis* (Fr.) Danser, *R. conglomeratus* Murr., and *R. acetosella* L. are naturalized in Japan.  
Lit. Rechinger f. in Candollea 12: 80 & 86 (1949).

<b>Tovara filiformis</b> (Thunb.) Nakai.....	<b>T. virginiana</b> (L.) Raf.
( <i>Polygonum filiforme</i> Thunb.)	( <i>P. virginianum</i> L.)
Kashmir, Burma, Tonkin, China, Manch.,	[S. Ontario, Minn. to s. w.
Korea, Yezo south to Formosa (2n=44)]	Quebec, south to c. Texas &
var. <b>apoensis</b> (Elmer) Hara	Florida
( <i>Polyg. apoense</i> Elmer)	var. <b>glaberrima</b> Fernald
Philippines (Mindanao)	Virginia to Florida

The Japanese plant has usually thin obovate leaves broadest in or above the middle with the shortly acuminate apex and the attenuate base, and glabrescent beneath or strigose-hairy on veins, and ovate achenes 2.2-3 mm long with dark red or reddish rarely whitish perianths. While the American one has ovate leaves broadest below the middle with the long acuminate apex and often pubescent also on the lower surface, and larger oblong-ovate achenes about 3.5 mm long with generally greenish perianths.

The Eastern Asiatic *T. filiformis* is variable in the hairiness of leaves, and the Chinese plants have often leaves strigose-hairy on both surfaces. Var. *smaragdina* (Nakai) Hara is a local variety with narrower leaves, and the Philippine plant also seems to be a variety of *T. filiformis*.

The closely allied race, *T. neofiliformis* Nakai, is easily recognizable in the field in having thicker flat leaves nearly glabrous on both sides and more long-attenuate to both ends, and slightly larger achenes than *T. filiformis*, and it occurs in Honshu, Shikoku, Kyushu, south Korea, and central China.

Lit. Steward in Contr. Gray Herb. 88: 13 (1930); F. Maekawa in Bot. Mag. Tokyo 46: 586 (1932).

<b>Chenopodium glaucum</b> L. ———	<i>C. glaucum</i> - - - - -	<i>C. glaucum</i>
c. Europe (2n=18), Caucasus, Asia Minor, Persia, Siberia		var. <b>salinum</b> (Standl.)
(east to Ochotsk, c. Kamt.),		Boivin (subsp. <i>salinum</i> Ael-
Himalaya, China, Manch., Korea,		len, <i>C. salinum</i> Standl.)
Saghal., Kuril., Yezo, n. & c.		Alaska (isol.), Lake Atha-
Honshu (south to Simôsa &		baska distr., British Colum-
Noto)		bia to N. Dakota, south to
		Arizona & New Mexico

Subsp. *Marlotianum* (Murr.) Thellung et Aellen in South Africa, subsp.

*ambiguum* (R. Br.) Thellung et Aellen in Australia to South America, and subsp. *Parodii* Aellen in South America.

Lit. Aellen in Fedde, Rep. 26: 45 (1929); Aellen & Just in Amer. Midl. Nat. 30: 60 (1943); Boivin in Canad. Field.-Nat. 65: 17 (1951).

<i>Salicornia europaea</i> L.	<i>S. europaea</i>	<i>S. europaea</i>
( <i>S. herbacea</i> L.)	C. Asia, Siberia (east in Dahuria	s. Alaska, w. Mackenzie,
Europe (2n=18, 36, 38),	& Ussuri), Asia Minor, Persia,	along coast to British Co-
Caucasus	India, n. China, Manchuria,	lumbia, Calif., Great Lake
	Korea, Saghal., s. Kuril., Yezo,	region, Newfld., south to
	Shikoku (isol.)	Georgia; West Indies

<i>Salsola Soda</i> L.	<i>S. Komarovi</i> Iljin
s. & e. Europe (2n=36),	[e. Siberia (Udsk, Ussuri), n. China,
Caucasus, C. Asia, w. Siberia]	Manch., Korea, Saghal., s. Kuril., Yezo,
	Honshu, Shikoku, Kyushu, Ryukyu

Compared with *S. Soda*, the Japanese plants have generally divaricate branches, stronger spinules at the apex of leaves and bracts, leaves often less dilatated at the base, acute perianth-lobes, and flowers which are often borne on short axillary branches and look as if pedunculate.

Lit. Hara in Bot. Mag. Tokyo 48: 897 (1934); Iljin in Fl. URSS. 6: 221 (1936).

<i>Suaeda maritima</i> (L.) Dumort.	<i>S. maritima</i>	<i>S. maritima</i>
Europe (2n=36)]	[Korea, c. & w. Honshu, Shi-	s. Alaska, Great Bear Lake,
n. Africa	koku, n. Kyushu, Ryukyu,	e. Quebec, south to Virginia
	Malaysia; Australia	

The Japanese plant well agrees with *S. maritima* of Europe in the characters of leaves, calyx-lobes and the surface of seeds, but has generally decumbent or spreading-ascending robust branches, dense flowering branches, leaves on flowering branches almost erect-ascending from the basal part in a fruiting stage, and even upper ones often several times longer than flowers, utricles entirely closed by sepals when fresh, and seeds less than 1.5 mm in diameter. Thus it differs slightly from the typical European plant, but this species is polymorphic also in Europe and North America, so I do not separate the Japanese plant which seems to be isolated geographically as an independent variety. Iljin has referred the plant which is closely allied to *S. maritima* in western Europe and southern Siberia to *S. prostrata* Pallas, and various allied species have been known in Asia, Europe and N. America.

Lit. Fernald in Rhodora 9: 144 (1907); Iljin in Fl. URSS. 6: 193 (1936); Backer in Fl. Malaysia ser. 1, 4 (2): 105 (1949).

<i>Montia lamprosperma</i> Cham.	<i>M. lamprosperma</i>	<i>M. lamprosperma</i>
( <i>M. rivularis</i> Gmelin)	[Ussuri, Ochotsk, Chukch, Kamt.,	Aleut., Alaska to British
n. & c. Europe (east to n.	Saghal., Kuril., Yezo, n. & c.	Columbia] [Baffin Is., La-
Russia) (2n=18)]	Honshu (rare); w. New Guinea	brador to Maine; Greenland
Africa (alp.)	(alp.)	

The Japanese specimens have stems rooting at the lower nodes, and lustrous seeds 1-1.2 mm long which are slightly elevated-areolate on the surface. The typical *M. lamprosperma* is considered to have stems not rooting at the nodes and larger seeds about 1.5 mm across. I could not, however, find definite differences between the Japanese plant and *M. lamprosperma* from eastern North America, and also *M. rivularis* from Europe. Especially they all agree well with each other in the sculpture and shape of seeds.

Lit. Fernald in *Rhodora* 12: 138 (1910); Nakai in *Bot. Mag. Tokyo* 46: 53 (1932); Hultén, *Fl. Alaska* 4: 645 (1944).

**Cucubalus baccifer** L. ————— *C. baccifer*

c. & s. Europe (2n=24), Caucasus, w. Siberia, C. Asia, Iran, Himalaya  
var. **japonicus** Miquel  
Amur, Manch., China, Korea, s. Saghal.,  
s. Kuril, Yezo, south to Kyushu,  
Formosa

The seeds of Japanese plants are generally smaller, roundish, and often quite smooth and very lustrous.

Lit. Hara in *Bot. Mag. Tokyo* 48: 899 (1934).

**Dianthus superbis** L. ————— *D. superbis*

Europe (2n=30, (60)), Caucasus, C. Asia, Siberia (east to Amur,  
var. **speciosus** Reichb. Ussuri), Mongolia, China, Manch., Korea,  
Europe (mts.) Saghal., c. & s. Kuril, Yezo, Honshu  
var. **monticola** Makino  
n. Korea, Saghal., s. Kuril, Yezo (2n=  
30), n. & c. Honshu (alp.)  
var. **longicalycinus** (Max.) Williams  
(*D. longicalyx* Miq.)  
China, Korea, Honshu, south to Formosa  
(2n=30)

In Japan this species is highly polymorphous, and includes several different races. Rather slender plants in the mountain districts and northern parts of Japan which have often reddish shorter calyces 2-3 cm long about 4 mm thick, have generally been referred to the typical form of *D. superbis*. The typical European form, however, has narrow oblong undivided parts of petal-limbs, while the Japanese one has broad rhombic undivided parts as in var. *speciosus* Reichb., and belongs to a slightly different form. A more robust form, var. *latifolius* Nakai, with broader leaves 6-10 mm wide, large flowers and thicker calyces, is found along the coasts also in northern Japan, i.e. northern Honshu, Yezo and Saghalien. From the alpine region of central Honshu north to Yezo, southern Kuriles (up to Urup), Saghalien and northern Korea, there occurs var. *monticola* Makino which has narrow leaves usually 1-3 mm wide, lower slender stems with 1-2(3) large beautiful flowers, thick shorter calyces 1.8-2.5 cm long 4-5 mm thick, 2-4 bracteoles at the base of calyx, and petal-limbs



deeply fimbriated into long filiform lobes and densely barbate with long purple hairs at the throat. A form (var. *amoenus* Nakai) which is very glaucous, and has slightly smaller flowers with narrower limbs and less barbate throats of petals is known on alpine mountains of central Honshu too. Forma *brevicalycinus* Maxim. seems to me to include more than one form above mentioned, and I am also not sure if var. *speciosus* of Europe exactly coincides with one of the Eastern Asiatic races.

Another extreme race is var. *longicalycinus* which is robust, and has often greenish long calyx 3-4 cm long 4-5 mm wide, 4-8 bracteoles, and petal-limbs with slightly shorter lobes. It is distributed from the lowlands of central Honshu south to Formosa and to eastern China (including Hainan) where a narrow-leaved form prevails, and it is sometimes treated as an independent species, *D. longicalyx* Miquel.

The two extremes, var. *monticola* and var. *longicalycinus*, which are very distinct in central Honshu, however, gradually merge into *D. superbus* in the northern districts through intermediate forms, and I cannot draw a strict line of demarcation between them. And also both glaucous and greenish forms are present in all races above mentioned.

Lit. Maxim. in Act. Hort. Petrop. 11: 64 (1890); Nakai in Bot. Mag. Tokyo 43: 456 (1929); Merrill in Sunyats. 1: 17 (1930).

<b>Honkenya peploides</b> (L.) Ehrh. — <i>H. peploides</i> ————— <i>H. peploides</i>	
& var. <i>diffusa</i> (Horn.) Kruuse	Siberia (w. arctic Siberia) [Chukch Penn.] n. Alaska to Labrador, south to Newfld.; Greenland
Europe (along the coasts) (2n=48, 64, 66)	subsp. <b>major</b> (Hook.) Hultén ————— subsp. <i>major</i>
	Ochotsk, Ussuri, Kamt., Korea, Aleutian, s. Alaska to Oregon] [w. Newfld.
	Saghal., Kuril., Yezo, Honshu subsp. <b>robusta</b> (Fern.) Hultén
	e. Labrador to Newfld., south to Virginia

Lit. Fernald in Rhodora 11: 109 (1909); Nakai in Bot. Mag. Tokyo 43: 457 (1929); Mattfeld in Pfl.-areale 2: map 52 (1929); Hultén, Fl. Aleut. 171 (1937), Fl. Alaska 4: 674 (1944).

<b>Melandrium apetalum</b> (L.) Fenzl — <i>M. apetalum</i> ————— <i>M. apetalum</i>	
( <i>Lychnis apetala</i> L.)	(subsp. <i>arcticum</i> (Fr.) Hultén, Aleut., Alaska, arctic Canada to Labrador; n. Greenland
n. Europe (2n=24)	f. <i>Okadai</i> Makino) n. Siberia (east to Chukch, subsp. <b>attenuatum</b> (Farr)
	Kamt.), C. Asia (mts.), Hima-Brit. Columbia to Alberta
	laya, Tibet] [c. Honshu (alp., (mts.)
	rare) subsp. <b>montanum</b> (S. Wats.)
	Montana to Colorado

It is remarkable that this species occurs very isolated in the alpine region of the Akaishi mountain-range in central Honshu. Its flowers are conspicuously nodding when young, and become erect in fruit, and its small petals are light lilac and shortly exserted from the calyx, and its inflated pubescent calyces

are 12–18 mm long, and thus it belongs to subsp. *arcticum* in Hultén's sense, or *L. apetala* var. *glabra* Regel in Boivin's sense.

Lit. Makino in Journ. Jap. Bot 2-2: 6 (1918); Koidzumi in Bot. Mag. Tokyo 33: 222 (1919); Hultén, Fl. Alaska 4: 700 (1944); Maguire in Rhodora 52: 235 (1950); Boivin in Canad. Field-Nat. 65: 5 (1951).

### *Minuartia arctica* (Stev.)

Ashers. et Graebn.	<i>M. arctica</i>	<i>M. arctica</i>
e. arctic Europe (arctic Russia, Nova Zembla)	Siberia (arctic, east to Chukch Penin. south to Jakutsk, Kamt.), n. Korea, Saghal., Yezo (alp.)	e. Aleutian, Alaska, to w. Mackenzie
	var. <i>hondoensis</i> Ohwi	<i>M. marcescens</i> (Fern.) House
	( <i>M. hondoensis</i> Ohwi)	w. Newfld., -Gaspé Penin.
	c. Honshu (alp.)	

The plants from Yezo have often slightly smaller flowers and seeds with more flat tubercles than the typical *M. arctica*. Var. *hondoensis* Ohwi on high mountains of central Honshu has generally small flowers, narrower petals, and almost smooth seeds without distinct tubercles. The report on the occurrence of *M. biflora* from central Honshu is doubtful.

Lit. Mattfeld in Pfl.-areale 2: map 61 (1924); Hultén, Fl. Kamt. 2: 78 (1928), Fl. Alaska 4: 678 (1944); Nakai in Bot. Mag. Tokyo 43: 452 (1929); Ohwi in Acta Phytotax. et Geobot. 3: 82 (1934), 5: 148 (1936).

### *Minuartia macrocarpa* (Pursh) Ostenf. — *M. macrocarpa*

Nova Zembla, Siberia (arctic Urals, east to Chukch)	w. & e. Aleut., Alaska, Yukon, w. Mackenzie
var. <i>minutiflora</i> Hultén	
Kamt., n. Kuriles	
var. <i>yezoalpina</i> Hara <sup>8)</sup>	
c. Yezo (Mt. Daisetsu)	
var. <i>Jooi</i> (Makino) Hara <sup>8)</sup>	
c. Honshu (alp.)	
var. <i>koreana</i> (Nakai) Hara <sup>8)</sup>	
n. Korea (alp.)	

In the Far East, the plants of this group occur in isolated localities in the alpine region, and they are represented by slightly differentiated races in central Yezo, central Honshu and northern Korea.

The Japanese plants have leaves with distinct ciliae, sepals 5–7 mm long,

8) *Minuartia macrocarpa* var. *yezoalpina* Hara, nom. nov.—*M. subfalcata* Nakai in Bot. Mag. Tokyo 43: 454 (1929), excl. syn.

var. *Jooi* (Makino) Hara, comb. nov.—*Alsine Jooi* Makino in Bot. Mag. Tokyo 17: 12 (1903). *A. macrocarpa* var. *Jooi* Makino, l. c. 17: 38 (1903). *Minuartia Jooi* (Makino) Nakai, l. c. 43: 453 (1929).

var. *koreana* (Nakai) Hara, comb. nov.—*Alsine macrocarpa* var. *koreana* Nakai in Bot. Mag. Tokyo 32: 36 (1918). *Minuartia imbricata* var. *koreana* (Nakai) Nakai in Bot. Mag. Tokyo 43: 453 (1929).

petals 8–10 mm long, capsules 8–14 mm long and seeds nearly smooth on both sides. The plant of Yezo, var. *yezoalpina*, is somewhat robust and has seeds with slightly shorter marginal papillae than the other plants. The Korean plant has often smaller flowers, and seeds slightly rugose on both sides. Var. *minutiflora* of Kamtchatka differs from var. *yezoalpina* in having leaves with very short ciliae, smaller flowers, sepals about 4 mm long, and seeds with longer marginal papillae and rugose on both sides.

Lit. Mattfeld in Fedde, Rep. Beih. 15: 195 (1922); Nakai in Bot. Mag. Tokyo 43: 453 (1929); Hultén, Fl. Kamt. 2: 80 (1928), Fl. Alaska 4: 682 (1944).

**Minuartia verna** (L.) Hiern ——— *M. verna*

Europe (2n=ca. 24, 78), Caucasus, n. & e. Siberia (east to Dahuria,  
n. Africa Jakutsk, Ochotsk?), e. C. Asia, n. Mongolia

var. **japonica** Hara<sup>9)</sup>

Saghal., Yezo (alp.), n. & c. Honshu  
(alp.)

var. **coreana** (Nakai) Hara<sup>9)</sup>

n. Korea (alp., isol.)



Fig. 2. *Minuartia verna* var. *japonica*  
Seed (× ca. 25).

The closely allied *M. rubella* (Wahlb.) Hiern (*Arenaria verna* var. *pubescens* (Cham. et Schl.) Fernald) is widely distributed in arctic regions of Europe, Siberia including Kamchatka, and North America southwards to the mountains of California and New Mexico, and Greenland.

*M. verna* is exceedingly polymorphic in Europe and Asia. In the Japanese plant, the stems are 3–15 cm high and 1-several-flowered; the stems, pedicels and calyces pubescent; the petals longer than or equal to sepals which are 2.5–3.5 mm long; and the seeds are 0.6–0.8 mm across, and minutely and slightly elevate-areolate, but without raised papillae (Fig. 2). It closely resembles the European *M. verna* in general appearance, but in the sculpture of seeds it is not distinguishable from the European and North America specimens of *M. rubella*.

Although some specimens from mountains of central Europe approach to the Japanese race, it is impossible at present to refer it with certainty to one of numerous forms described in Europe, so I name it here as *M. verna* var. *japonica* Hara<sup>9)</sup>. Critical monographic studies of this group are much needed, and eastern Siberian specimens should be carefully compared with the Japanese plant.

9) *Minuartia verna* var. **japonica** Hara, var. nov. —Caulis 3–15 cm altus 1-pluri-florus pedicellique glanduloso-pubescens. Sepala 2.5–3.5 mm longa. Petala longiora quam sepalis vel subaequilonga. Semina 0.6–0.8 mm in diametro, superfacie tenuiter elevato-areolata ut in *M. rubella*. Typus. Yezo: in monte Horoman, prov. Hidaka (H. Hara, Jul. 11, 1933 in Herb. Univ. Tokyo).

var. **coreana** (Nakai) Hara, comb. nov. —*Alsine verna* var. *coreana* Nakai in Bot. Mag. Tokyo 32: 230 (1918).



Lit. Aschers. & Graebn., Syn. Mitt.-Europ. Fl. 5-1: 734 (1918); Fernald in Rhodora 21: 21 (1919); Hayek in Oester. Bot. Zeits. 71: 89 (1922); Nakai in Bot. Mag. Tokyo 43: 450 (1929); Hara in Bot. Mag. Tokyo 48: 901 (1934).

**Moehringia lateriflora** (L.) Fenzl — *M. lateriflora* — *M. lateriflora*  
 n. & e. Europe, Asia Minor, C. Asia, Siberia (east to Ussuri, Aleut., Alaska to Labrador,  
 Ochotsk, Chukch, Kamt.), n. south to n. Oregon, Utah,  
 Mongol., n. China, Manch., New Mexico, Missouri &  
 Korea, Saghal., Kuril., Yezo, New Jersey  
 Honshu, Shikoku, Kyushu

This species is polygamous, and in central Honshu I have observed two types of flowers on different individuals. Some have larger hermaphrodite flowers 10-14 mm in diameter, exerted stamens 4-5 mm long, and styles 1-2.5 mm long, but some other individuals have smaller flowers 7-9 mm in diameter, abortive stamens 0.8-2 mm long, and long styles 2.5-3 mm long.

Lit. St. John in Rhodora 19: 259 (1917); Bulavkina in Bull. Jard. Bot. Princ. URSS 25: 23 (1926); Hara in Biosphaera 1 (7): 247 (1947).

**Sagina maxima** A. Gray — *S. maxima*  
 (*S. litoralis* Hult., *S. Taquetii* Lév.) Aleut., s. Alaska  
 Ussuri, Korea, Saghal., Kamt., Yezo,  
 south to Formosa, Bonin (2n=42  
 or 44)  
 var. **crassicaulis** (Watson) Hara — var. *crassicaulis*  
 Saghal., Kuril., Kamt., Yezo Aleut., s. Alaska, along the  
 coast to California

The plant is common near the sea-shore in Japan, and is very variable, but my conviction, based on ample materials, is that it belongs to a single species.

*S. maxima*, of which I have examined the type specimen, has sparsely glandular-pubescent pedicels and calyces, and seeds with flattish round tubercles, and is the same as *S. litoralis*, although it varies much in the size of plant according to the condition of habitat. The plant on sandy sea-shores of southern Japan is robust in all parts and has decumbent stems, thick succulent lustrous radical leaves, and densely pubescent calyces (f. *littorea* Makino), but in the inland it becomes taller and more slender with thinner leaves (f. *viatica* (Ohwi)). In var. *crassicaulis*, a whole plant is glabrous, and its seeds are often nearly smooth.

The sculpture on the surface of seeds in the above forms is fundamentally the same, but it is variable in the degree of swelling of undulate areolae, becoming round-tuberculate in one case and smooth in the other extreme case. I have examined various transitional Japanese specimens completely interconnecting the forms above mentioned.

A common weed in Eastern Asia with minutely echinulate seeds is often confounded with *S. maxima*, but it should properly be distinguished as *S.*

*japonica* (Swartz) Ohwi. cf. Ohwi in Journ. Jap. Bot. 13: 438 (1937); Hara in Rhodora 41: 391 in adnota (1939), in Journ. Jap. Bot. 17: 394 (1941).

Lit. Nakai in Bot. Mag. Tokyo 38: 230 (1924); Hultén, Fl. Kamt. 2: 78 (1928), Fl. Alaska 4: 670 & 673 (1944); Hara in Journ. Jap. Bot. 13: 556 (1937), in Rhodora 41: 391 (1939); E. Wright in Journ. Bot. 78: 37 (1940); Ohwi in Acta Phytotax. et Geobot. 11: 251 (1942).

**Silene repens** Patr. ex Persoon — *S. repens*, — — — — — *S. repens*

Europe Russia, Siberia (east to Amur, Ussuri, Ochotsk, Kamt.),	var. <b>purpurata</b> (Greene)
C. Asia, n. e. Tibet, Mongol., Manch.,	Alaska east to Eskimo
n. Korea, Saghal., s. Kuril., n. Yezo	Lake of Mackenzie distr.
(Isl. Rebun)	var. <b>australe</b> (H. & M.)
var. <b>apoiensis</b> Hara <sup>10)</sup>	Idaho, w. Montana &
s. Yezo (Mt. Apoi, Mt. Horoman)	Wyoming

Although this species is polymorphous, the plants of the Far East, approaching to the N. American ones, have often lower stems, fewer flowers, thicker calyces and larger seeds than the typical Siberian form. Specimens from southern Kuriles are densely pubescent, particularly on pedicels and calyces with long soft hairs, and have broader oblong- or ovate-lanceolate leaves which are (3) 7-14 mm wide, acuminate at the top and pubescent on both sides; and those from Saghalien have usually narrower lanceolate or linear-lanceolate leaves 3-6 mm wide. Some specimens from southern Kuriles and Is. Rebun agree with f. *alpina* Hultén of Kamtchatka. Var. *apoiensis* Hara<sup>10)</sup> isolated in southern Yezo is less pubescent with short hairs, and has stiff patent narrow leaves which are glabrous except the margin, and white or slightly rosy petals. A form which is yellowish green in all parts is rarely found also on Mt. Horoman.

Lit. Takeda in Bot. Mag. Tokyo 24: 156 (1910); Hultén, Fl. Kamt. 2: 90 (1928); Hara in Bot. Mag. Tokyo 48: 903 (1934); Hitchcock & Maguire in Univ. Washingt. Publ. Biol. 13: 20 (1947).

**Spergularia marina** (L.) Griseb. — *S. marina* — — — — — *S. marina*

( <i>S. salina</i> J. et C. Presl)	( <i>S. salina</i> var. <i>asiatica</i> Hara)	( <i>S. leiosperma</i> Kindb.)
Europe (2n=36), Caucasus,	C. Asia, Siberia (east to Amur)	[British Columbia to Quebec,
	Ussuri), Mongolia, n. China,	south to Calif., New Mexico,
	Manch., Korea, Saghal., s.	Texas & Florida; s. America
	Kuril., Yezo, Honshu (rare),	
	w. Kyushu (rare)	

10) *Silene repens* var. **apoiensis** Hara, var. nov. — *S. repens* var. *angustifolia* sensu Hara in Bot. Mag. Tokyo 48: 903 (1934).

Caulis 5-25 cm altus rubescens minute pubescens, internodiis vulgo abbreviatis. Folia patentia lanceolata-linearilanceolata 1.5-4 cm longa 2-7 mm lata rigidula praeter margine glabra. Calyces paullo inflati 10-15 mm longi 4-6 mm crassi pubescentes rubescentes, lobis obtusis. Petala alba vel intus dilute rosea. Semina ca. 1.2 mm longa tuberculata.

Typus. Yezo. Prov. Hidaka: in monte Horoman (H. Hara no. 3465b, Jul. 11, 1933 in Herb. Univ. Tokyo).

The Eastern Asiatic specimens slightly differ from the typical European ones in having smaller sepals and elongate leafy bracts, and agree rather with some North American ones. A few Japanese specimens have smooth seeds and are referable to f. *leiosperma* (Kindb.). All these specimens, however, fall within the limit of variations of *S. marina* defined by Rossbach.

Lit. Fernald & Wiegand in *Rhodora* 12: 157 (1910); Hara in *Journ. Jap. Bot.* 13: 171 (1937); Rossbach in *Rhodora* 42: 123 (1940).

<i>Stellaria Alsine</i> Grimm	<i>S. Alsine</i>	<i>S. Alsine</i>
( <i>S. uliginosa</i> Murray)	Caucasus, w. Siberia, Himalaya,	[Newfld. to Maryland
Europe (2n=24, 26);	w. China	
n. Africa	var. <i>undulata</i> (Th.) Ohwi	
	(var. <i>phaenopetala</i> Hand.-Mzt.)	
	China, Manch., Korea, s. Kuril.]	
	Yezo south to Formosa	

The Japanese plant has usually large petals which are longer than sepals, and is growing abundantly in rice-fields and cultivated grounds.

Lit. Handel-Mazzetti, *Symb. Sinic.* 7 (1): 191 (1929); Ohwi in *Acta Phytotax. et Geobot.* 10: 136 (1941); Fernald in *Rhodora* 52: 250 (1950).

<i>Stellaria calycantha</i>	<i>S. calycantha</i>	<i>S. calycantha</i>
(Ledeb.) Bong.	( <i>S. yessoalpina</i> Nakai)	( <i>S. borealis</i> Bigel.)
n. Europe (east to Urals)]	[Ochotsk, Kamt., Aleut., Saghal.,	Alaska to Labrador, south
(2n=ca. 44-48)	n. & c. Kuril, c. Yezo (alp.,	to Calif., Colorado, Minn.
	isol.), c. Honshu (alp., isol.)	& New Jersey, with several
		varieties; Greenland

Lit. Fernald in *Rhodora* 16: 144 (1914), 42: 254 (1940); Hultén, *Fl. Alaska* 4: 648 (1944); Boivin in *Canad. Field.-Nat.* 65: 7 (1951).

<i>Stellaria humifusa</i> Rottboell	<i>S. humifusa</i>	<i>S. humifusa</i>
n. Europe (2n=26), n. Siberia (arctic, east to Ochotsk, Ussuri,	Sajan, Kamt., Chukch), Saghal.,	Alaska, arctic Canada to
	Kuril., Yezo	Labrador, south to Oregon,
		Hudson Bay & Maine;
		Greenland

<i>Stellaria longifolia</i> Muhl.	<i>S. longifolia</i>	<i>S. longifolia</i>
( <i>S. diffusa</i> Willd., <i>S. mo-</i>	Siberia (east to Kolyma, Ussuri,	e. Alaska to Newfld., south
<i>squensis</i> Bieb.)	c. Kamt.), Manch., n. Korea,	to Oregon, Utah, New
n. & c. Europe (2n=26)	Saghal., s. Kuril, Yezo	Mexico, Louisiana & Vir-
		ginia

The Japanese plant agrees well with the American *S. longifolia*. Its capsules are 3-5 mm long, slightly or distinctly exceeding sepals, and yellow-greenish or brownish, or brownish black when mature. A form with almost black capsules is not uncommon in Saghalien, and it corresponds to var. *atrata* J. W. Moore of Minnesota, but its sepals are not ciliolate.

Lit. Hara in *Bot. Mag. Tokyo* 48: 905 (1934); Miyabe et Tatewaki in *Trans. Sapporo Nat. Hist. Soc.* 13: 378 (1934).



***Stellaria nemorum* L. .... S. *Bungeana* Fenzl**

Europe (2n=26), Caucasus, (*S. nemorum* var. *Bungeana* Regel)  
 Asia Minor e. Europe Russia, Siberia (east  
 to Amur, Ussuri), n. China, Mongol.,  
 Manch., n. Korea, Saghal., Yezo

***Brasenia Schreberi* J. F. Gmelin ——— *B. Schreberi***

India, China, Korea, Amur, Ussuri, [s. Alaska, south to Calif.]  
 c. & w. Yezo, south to Kyushu] [Manitoba to Nova Scotia,  
 Formosa; s. w. Africa; Australia south to Texas & Florida;  
 Cuba, Mexico, C. America (2n  
 = 80?)

***Nuphar pumilum* (Timm) DC. — *N. pumilum* ..... *N. microphyllum***

n. & c. Europe (2n=34), s. Siberia (east to Amur, (Pers.) Fern.  
 Ussuri, Kamt.), Manch., Manitoba to Newfld., south  
 Saghal., s. Kuril., e. Yezo, n. to Minn., Michigan, n. New  
 Honshu (mts., isol.) Jersey (2n=34)  
 var. *ozeense* Hara  
 c. Honshu (Oze, isol.) (2n=34  
 Sinoto & Takemasa, ined.)

This species shows considerable variations in Eastern Asia as in Europe. The stigma-disk is 8-14 (-20)-rayed; the fruits are generally ovoid with the thick elongated neck, but sometimes nearly globose; the seeds are 3.2-3.8 × 2-2.5 mm in size.

In northern Honshu, it occurs only in five stations which are all isolated on mountains about 1000-1400 m high above the sea-level. It is very remarkable that the plant of Ozegahara which is the southernmost locality, has always dark red stigma-disk (var. *ozeense* Hara).

Lit. Schuster in Bull. Herb. Boiss. ser. 2, 7: 913, 981 (1907), 8: 69 (1908); Miki, Water Phaner. Jap. 84 (1937); Hara in Bot. Mag. Tokyo 64: 74, map (1951).

***Nymphaea tetragona* Georgi — *N. tetragona* - - - - - *N. tetragona***

Europe (Finland, Russia) (2n=112), Siberia (east to subsp. *Leibergii* (Morong)  
 Ussuri, Ochotsk, Kamt.), n. India, Porsild  
 China, Manch., Korea, Saghal., s. Alaska, British Columbia, Wa-  
 Kuril., Yezo, Honshu, Shikoku, shing., Idaho] [n. Minn. east  
 Kyushu, Formosa to Quebec & n. Maine (2n=120)

In Eastern Asia this plant is very variable in the size of leaves and flowers and in the number and shape of petals. A form with fewer broader petals (var. *lata* Caspary) is found more often in northern regions.

Lit. Caspary in Miq., Ann. Mus. Lugd.-Bat. 2: 251 (1866); Conard, Waterlilies (1905); Hultén, Fl. Alaska 10: 1740 (1950).

***Ceratophyllum demersum* L. ——— *C. demersum* ——— *C. demersum***

Europe (2n=ca. 24), Caucasus, C. Asia, Siberia (east to Ussuri), British Columbia to Nova  
 n. & s. Africa; with var. *apiculatum* (Cham. & Schl.), China, Korea, Yezo, south to Scotia, south to Calif. &  
 Formosa, Malaysia Florida; C. & S. America

var. *platyacanthum* (Cham.), & var. *quadrispinum* Makino  
 var. *pentacanthum* (Haynald). (var. *pentacorne* Kitag., *C.*  
*oryzolorum* Komarov)  
 Ussuri, Manch., China, Korea,  
 Honshu, Kyushu, Formosa

*Anemone narcissiflora* L. ——— *A. narcissiflora* ——— *A. narcissiflora*  
 Europe (2n=14), Caucasus, Siberia (east to Ussuri, Ochotsk, Aleut, Alaska, w. Mackenzie,  
 Kamt.), China, n. Korea, Sag- to Alberta, Wyoming, Colo-  
 hal., Kuril., Yezo (2n=14), rado & Iowa; with several  
 n. & c. Honshu (alp.), Shikoku races.  
 (alp.); with several races.

As Hultén has pointed out, there are many local races in *A. narcissiflora*. In the Japanese Archipelago, we notice that the northern plants tend to be more robust, densely villose and to have often obtuse leaf-lobes compared with the plants in the alpine regions of Honshu which are generally more slender and sparsely hairy and have often narrower acute leaf-lobes. In Japan the size of plants, the length of petiolules, the number of flowers, the length of peduncles and the size of flowers and fruits vary by the condition of the habitat, and also by individuals.

The northernmost race, var. *villosissima* DC. occurs in Alaska, Aleutians, Kamtchatka and Kuriles in its typical form, but in southern Kuriles some specimens come near to var. *sachalinensis*.

Var. *sachalinensis* Miyabe et Miyake which is more slender and thinly villose than var. *villosissima*, is found on high mountains of Yezo, northern Honshu and also Korea as well as in Saghalien. And this form gradually passes through intermediate forms into a form with narrower and acute leaf-segments which is often met with in the alpine regions of central Honshu. It is interesting that this last form closely resembles the European *A. narcissiflora*, although the European one is generally more hairy than the Japanese. I have also observed similar variations in specimens of the European Alps.

Var. *sikokiana* Makino (*A. sikokiana* Mak.) which has often compound umbellate inflorescences and smaller flowers, is known from Mt. Ishidzuchi in Shikoku and Quelpaert.

In north China, Jehol and Mongolia, there occurs another race, var. *pekinensis* Schipcz. (var. *chinensis* Kitagawa, *A. demissa* var. *glabrescens* Ulbrich) which is glabrescent and has less dissected leaves with obtuse lobes, and the closely allied *A. demissa* Hook. f. et Thoms. in Himalaya.

The differences between the races above mentioned which mostly concern the shape of leaf-lobes and the hairiness are so slight, and they are interconnected by so many transitional forms that I do not treat them as distinct subspecies as Hultén did.

Lit. Schipczinsky in Acta Hort. Bot. Univ. Jurejev. 13: 85 (1912); Juzepczuk in Fl. URSS. 7: 269 (1937); Hultén, Fl. Alaska 4: 732 (1944).

<i>Caltha palustris</i> L.	<i>C. palustris</i>	<i>C. palustris</i>
Europe (2n=(28) 32, 48, 56, (58, 60)), s. Caucasus; with several races.	w. Himalaya, China, Siberia (east to Ussuri, Kamt., Chukch), Manch., Korea, Saghal., Kuril., Yezo, Honshu, Kyushu; with several races.	Alaska to Labrador, south to Alberta, Nebraska, Tenn. & S. Carolina var. <i>asarifolia</i> (DC.) Huth Aleutian, s. Alaska, along the coast to Oregon

*C. palustris* is a polymorphous species, and is very variable in the shape, size and mode of dentation of leaves, the length of peduncles, the size of flowers and the shape of styles and follicles. It is apparent that there are several races in Europe, N. America and Asia, but it is difficult to draw sharp lines of demarcation between them.

Compared with the typical European plant, the Eastern Asiatic ones have a tendency to have more reniform radical leaves with the more open sinus and with coarse deep teeth especially on the lobes and the upper stem-leaves. The common race in Japan with erect flowering stems has ovaries with distinct slender and often recurved styles as in European var. *cornuta*, and follicles which, when fully matured, are spreading and often recurved on the back and have a distinct beak 1.5–3 mm long. The sepals vary from 1 cm to 2 cm in length. This race has been referred to var. *membranacea* Turcz. described from the Baical, but seems to differ from it, and *C. membranacea* (Turcz.) Schipczinsky includes several different forms. So I here propose a new name, var. *nipponica* Hara<sup>11)</sup>, for it.

The plants from south-western Japan are slender, and sometimes have styles distinctly winged. They have smaller leaves and flowers, and thus approach to an extreme form, var. *pygmaea* Makino (2n=18, Miduno ined.), which has been known in Japanese gardens from old days, and is very rarely cultivated now. Some puzzling forms are present in Korea and Manchuria.

Another race, var. *Enkoso* Hara, nom. et stat. nov. (var. *sibirica* f. *decumbens* Makino in Bot. Mag. Tokyo 22: 176, 1908) has spreading decumbent flowering stems and shorter thick styles, and it occurs in northern Japan and is also cultivated.

The most distinct race in northern Japan (Saghalien, Yezo, s. Kuriles and n. Honshu?) is *C. fistulosa* Schipcz., and it has erect robust and fistulose stems, roundish radical leaves with the closed sinus, large leaves with small subequal

11) *Caltha palustris* var. *nipponica* Hara, var. nov. — Folia radicalia cordata—reniformia, sinu saepe late aperto, praecipue in lobis grosse saepe acuteque serrata. Caulis sub anthesin erectus. Sepala 1–2 cm longa. Styli distincti graciles apice saepe recurvi. Folliculi maturi divaricati saepe etiam dorso recurvi, rostro 1.5–3 mm longo.

Typus. Honshu, Prov. Iwashiro: ad lacu Oze-numa, 1600 m. alt. (H. Hara, Jul. 3, 1941 in Herb. Univ. Tokyo).

Dist. Kuriles austr., Sachalin, Yezo, Honshu, Korea bor., Manshuria?



numerous teeth, and ascending-erect follicles with a shorter beak 1-2 mm long.

The exact relationship between these many races is difficult to state without a monographic work of the genus.

Lit. Schipczinsky in Not. Syst. Herb. Hort. Petrop. 2: 166 (1921); Koidzumi, Fl. Symb. Or.-Asia. 77 (1930); Hara in Bot. Mag. Tokyo 49: 10 (1935); Hultén, Fl. Alaska 4: 711 (1944).

<b>Coptis trifolia</b> (L.) Salisb. ————— <i>C. trifolia</i>	
Jakutsk, Ochotsk, Kamt.,	Aleut., Alaska, British Columbia, Ma-
Ussuri, Saghal., Kuril.,	nitoba to s. Baffin, Labrador, south to
Yezo, n. & c. Honshu	n. Iowa to New Jersey, Tenn., N.
(alp.)	Carolina (mts.); s. Greenl. (2n=18)

I agree with Hultén's opinion that the American plant cannot be distinguished from the Eastern Asiatic as a separate geographical race. The Japanese plant is variable in the discriminative characters which Fernald has pointed out.

Lit. Fernald in Rhodora 31: 136 (1929); Hultén, Fl. Aleut. 177 (1937), Fl. Alaska 4: 715 (1944); Satake in Journ. Jap. Bot. 24: 73 (1949).

<b>Hepatica nobilis</b> Schreber - - - - <i>H. nobilis</i> .....	<b>H. americana</b> (DC.) Ker
( <i>Anemone Hepatica</i> L.)	var. <i>asiatica</i> (Nakai) Hara
Europe (2n=14)]	( <i>H. asiatica</i> Nakai)
	[Ussuri, Manch., Korea
	var. <b>nipponica</b> Nakai
	Honshu (2n=14)
	var. <b>japonica</b> Nakai
	Honshu, Shikoku, n. Kyushu
	(2n=16?)
	<b>H. acutiloba</b> DC.
	Minn. to Quebec, south to
	Missouri & Georgia (2n
	=14)

In Japan this species is variable in the shape and colour of leaves and sepals. A white-flowered form is common on the Pacific side, while a rose- or purple-flowered one prevails on the side of Japan Sea.

The plant has long been cultivated as a pot plant in Japan for its early blooming habit, and many horticultural forms which vary particularly in the size, shape, number and colour of petal-like sepals, were recorded in old Japanese literatures.

*H. maxima* Nakai of Dagelet Island is distinct in its large size and its glabrous ovaries with short stigma.

Miller used the names, *Hepatica nobilis*, *H. vulgaris*, *H. plena*, etc. in 1768, but as varieties.

Lit. Fernald in Rhodora 19: 45 (1917); Nakai in Journ. Jap. Bot. 13: 227 & 305 (1937).

<b>Ranunculus acris</b> L. ————— <i>R. acris</i> (with varieties) ————— <i>R. acris</i>	
Europe (2n=14, 16, 28, (13,	Siberia, China
15, 17, 18, 29-32))	var. <b>nipponicus</b> Hara
	( <i>R. novus</i> Lévl. et Vnt.)
	Yezo, n. & c. Honshu (alp) (2n=14)
	w. Aleutian; Greenland

**R. japonicus** Thunb. (with varieties)

e. Siberia, Mongolia, Manch., China, Korea, s. Yezo, south to Formosa (2n=14, Miduno ined.)

**R. grandis** Honda (with varieties)

Manch., Saghal., Kuril., Kamt?, Yezo, n. & c. Honshu (mt.)

The plants of this group are exceedingly polymorphic in Eastern Asia as well as in Europe, and the height of stems, the shape of leaf-segments and the size of flowers are variable in all races.

The Japanese race nearest to the European *R. acris*, is var. *nipponicus* Hara which occurs in the alpine regions of Yezo and Honshu. It has well-developed cauline leaves similar to radical ones, and broader leaf-segments than *R. acris*. Its stems and petioles are glabrescent or sparsely appressed hairy.

*Ranunculus japonicus* Thunberg differs from *R. acris* by having always patently hirsute stems and petioles, broad leaf-segments with shallow serration, and sessile inconspicuous stigmas. It is common on hills and mountains and is widely distributed in Japan, Korea, and China. In the northern part of the area, i.e. north China, Manchuria and Korea, a glabrescent form<sup>12)</sup>, in which hairs on stems and petioles are partly appressed, and the lower part of stems is often glabrescent, is prevailing.

*R. propinquus* C. A. Meyer also closely allied to *R. japonicus*, is sparsely pilose with always appressed hairs, and has apiculate achenes with a distinct beak.

Another characteristic race in Japan is *R. grandis* Honda which has long creeping subterranean stolons, and it differs from *R. acris* also in thicker leaves of a different shape, less curved styles and more densely hairy stems and leaves.

Many species and varieties of this group have been described from Siberia, and they should be critically revised.

Lit. Hara in Journ. Jap. Bot. 13: 775 (1937), 19: 359 (1943).

**Ranunculus repens** L. - - - - - *R. repens*

Europe (2n=16, 32), Caucasus, Persia, Siberia; with several varieties.

var. **major** Nakai  
Ussuri?, Kamt., Manch., n. China?, n. Korea, Saghalien, Kuril., Yezo (2n=32), n. Honshu (south to Prov. Shimotsuke, rare)

12) *Ranunculus japonicus* Thunb. var. **glabriusculus** Hara, var. nov. — Caulis parce patentim vel adpresse pilosus vel interdum subglaber. Petioli patentim vel adpresse pilosi. Cetera ut in typ.

Typus. China. Ôreikan, prov. Shansi (M. Tatewaki, no. 564, Mai 12, 1942 in Herb. Univ. Tokyo)

f. **sinoplenus** Hara, f. nov. — Flores perfecte pleni ca. 1 cm in diametro.

Typus. Ibidem (M. Tatewaki, no. 565, Mai 12, 1942).

The Eastern Asiatic plant is often more robust and glabrescent, and has deeply dissected leaves with narrower acute lobes than the European, and it represents a good geographical variety. The size of flowers is variable. Var. *glabratus* DC. seems to be a glabrescent form of the European race.

Lit. Nakai in Bot. Mag. Tokyo 42: 23 (1928); Benson in Amer. Midl. Nat. 40: 29 (1948).

<b>Ranunculus reptans</b> L.	<i>R. reptans</i>	<i>R. reptans</i>
( <i>R. Flammula</i> L. var. <i>filiformis</i> (Michx.) Hook.)	Siberia (east to Ochotsk, Kamt., Chukch), n. Mongol., Saghal., Kuril., Yezo	Aleut., Alaska to Labrador, south to Calif. (mts.), Colorado, Michigan & New Jersey; with var. <i>ovalis</i> (Bigel.) Torr. et Gray;
n. & c. Europe (2n=32)	var. <b>flagellifolius</b> (Nakai) Ohwi	Greenland
	c. Honshu (mts. of Nikko & Oze) (2n=32, Miduno, ined.)	

The plants isolated in central Honshu (ca. 1500 m high) have always subulate or linear leaves, but agree with some specimens from Europe, eastern North America and Greenland. The plant of Saghalien has linear leaves, while most of specimens from Kuriles has broader leaves.

Lit. Fernald in Rhodora 19: 135 (1917); Nakai in Bot. Mag. Tokyo 42: 24 (1928); Ohwi in Act. Phy. Geo. 1: 36 (1932); Benson in Bull. Torrey Bot. Cl. 69: 304 (1942), in Amer. Midl. Nat. 40: 185 (1948).

<b>Ranunculus sceleratus</b> L.	<i>R. sceleratus</i>	<i>R. sceleratus</i>
Europe (2n=32), Caucasus, Iran, India, Siberia, Mongol., China, N. Africa (intr.)	Kamt. (intr.), Saghal., Yezo to Formosa (2n=16, Miduno, ined.)	Alaska to Newfld., south to Calif., Florida (intr.)
		var. <b>multifidus</b> Nuttall (subsp. <i>m.</i> (Nutt.) Hultén)
		Alaska to Calif., east to New Mexico, Michigan & New Brunswick

<b>Ranunculus trichophyllus</b> Chaix	<i>R. trichophyllus</i>	<i>R. trichophyllus</i>
Europe (2n=16), Caucasus, Siberia (east to Ussuri?, Kamt?) Africa		Aleut., Alaska to Baffin, Labrador, south to Calif., Minn. & New Jersey; with varieties; Mexico; S. America
	<b>R. nipponicus</b> (Makino) Nakai	
	Saghal., Kuril., Yezo, Honshu (2n=48, Miduno ined.), Kyushu	

The plants of this group are highly variable in Asia as well as in Europe. The Japanese plant differs from the typical *R. trichophyllus* of Europe in having longer and tender capillary leaf-segments, peduncles which are much longer than leaves, 3-9 cm long and are often nearly straight in fruit, (10) 14-18 (20) shorter stamens, and achenes 1.5-2.2 mm long excluding the beak. It grows in streams and rarely in ponds of cool clean water, and it is a higher polyploid.

The plants of China and Korea have generally achenes which are slightly smaller (ca. 1.2 mm long), and sparsely pilose or glabrous. Those from north China have often short and stiff leaf-segments, and extreme specimens with



flabellate-cuneate leaves 1-3 cm long and flat linear (ca. 1 mm wide) leaf-segments, are named as *R. Bungei* Steudel. *R. Kauffmanni* Clerc described from Urals is also closely allied to the Japanese plant.



Fig. 3. Floating leaves of *Ranunculus nipponicus* (C), var. *major* Hara (A), and var. *japonicus* Hara (B).  $\times$  ca. 1.

Until the races in Siberia and China are critically revised and carefully compared with the Japanese plant, I treat of the latter as an independent species, *R. nipponicus*. Some specimens from Kamtchatka, Aleutians and Alaska are also difficult to separate from the Japanese plant.

*R. nipponicus* was originally named to a form with small floating leaves (Fig. 3 C). In Japan the plants with floating leaves are very localized, and are known only from several places in central Honshu (Fig. 3 A, B). The

development of floating leaves are rather poor even in those localities, and the individuals without floating leaves which are growing at the same place, cannot be distinguished from the common Japanese plant with submersed leaves only. Lit. Drew in *Rhodora* 38: 18 (1936); Kreczetovicz in *Fl. URSS.* 7: 335 (1937); Benson in *Amer. Midl. Nat.* 40: 232 (1948); Hara in *Bot. Mag. Tokyo* 60: 77 (1949).

***Thalictrum alpinum* L.**

n. & c. Europe ( $2n=14$ ),  
Caucasus

***T. alpinum***

Siberia (east to Ajan, Kamt.,  
Chukch), Pamir, Tibet, Mon-  
golia, China, n. Kuril., Saghal.

var. ***stipitatum*** Yatabe

(*T. nippono-alpinum* Honda)

c. Honshu (alp.) ( $2n=14$ )

var. ***microphyllum*** (Royle)

Hand.-Mzt.

Himalaya, Kashmir, w. China  
(alp.)

***T. alpinum***

Alaska, Yukon, w. Macken-  
zie; Idaho, Calif. & Colo-  
rado] [Labrador to Gaspé  
Penin., Quebec; Greenland

This species widely distributed in the Northern hemisphere is highly polymorphous. Although extreme forms look very different from each other, it is difficult to divide this species into some distinct geographical races, as parallel variations are often observed, when ample materials are examined.

The typical *T. alpinum* has nearly sessile achenes and recurved fruiting peduncles which are about 1 cm long, and the plants from Europe, Siberia including northern Kuriles and North America, mostly belong to this type. Slightly aberrant forms are sometimes found, and the specimens from Mt. Wutai in north China have almost straight ascending fruiting peduncles 3-24 mm long, and a specimen from south Kansu has elongate peduncles attaining

3.5 cm long, and Hegi illustrated stipitate achenes in his Ill. Fl. Mitt.-Europ. 3: t. 121, fig. 3 (1912).

The plant isolated in the alpine region of central Honshu, i. e. var. *stipitatum* Yatabe, is very striking in having distinctly stipitate ovaries and achenes, elongate fruiting peduncles 8–30 (40) mm long, thinner deeply incised leaflets which are slightly glaucous beneath and cuneate at the base. And it is remarkable that a specimen from York River, Gaspé County, Quebec (Williams, Collins & Fernald, Jul. 29, 1905 in Gray Herb.) is hardly distinguishable from the Japanese plant.

Although all plants with stipitate achenes are sometimes referred to var. *stipitatum*, most of them do not exactly agree with the Japanese. For example, a specimen from central Saghalien is near to the typical form except for its stipitate achenes, and specimens from Himalaya, Kashmir and western China, i. e. var. *microphyllum* (Royle) Hand.-Mzt., have stipitate achenes, but have short peduncles as in the typical form. And also in Himalaya, a form with almost sessile achenes is observed.

Lit. Handel-Mazzetti, Symb. Sin. 7 (2): 311 (1931), in Act. Hort. Gotob. 13: 172 (1939); Honda in Bot. Mag. Tokyo 53: 334 (1939); Boivin in Rhodora 46: 352 (1944).

#### **Thalictrum**

- aquilegifolium** L. - - - - *T. aquilegifolium*  
 Europe (2n=14)] var. **sibiricum** Regel et Tiling  
 (var. *asiaticum* Nakai, *T. contortum* L.)  
 [Siberia (east to Amur, Ussuri, Ochotsk,  
 Kamt.), Mongolia, Manch., n. China, Korea,  
 Saghal., Yezo, Honshu (2n=14), Shikoku  
 (mts.)  
 var. **intermedium** Nakai  
 Yezo, n. & c. Honshu (mts.)



Fig. 4. *Thalictrum aquilegifolium* var. *sibiricum* (A), var. *intermedium* (B). Fruits ( $\times 2$ ).

The European plant has oblong fruits 1–1.2 cm long about 4 mm wide with slender stipes and often purplish filaments. The Eastern Asiatic plants are variable, particularly in the shape of fruits, but a race (var. *sibiricum*) with often taller stems, shorter obovate fruits 5–8 mm long 3.5–4.5 mm wide with shorter stipes, and white filaments, occurs widely in Eastern Asia from Ochotsk to north China, Korea and Japan, although I have had no chance to examine materials from Kamtchatka and Dahuria. A specimen from Lao Shan of Shantung has obovate but larger fruits about 1 cm long.

On mountains of northern Japan, another form is present: var. *intermedia* Nakai, which has narrow oblong fruits similar to the European or narrower, but has shorter stipes of fruits and white filaments. The names, *T. kamikavense* Lév., *T. anomalum* Lév. et Vnt. and *T. mitinokuense* Koidzumi, were given to forms with narrow fruits, but they are connected with var. *sibiricum* through intermediate forms.

Lit. Nakai in Journ. Jap. Bot. 13: 473 (1937).

Typus. Kyushu. Prov. Bungo: mt. Tsurumi (S. Saito, Nov. 3, 1926 in Herb. Univ. Tokyo).



The most distinct race<sup>13)</sup> from the typical one occurs in Japan, Korea, Manchuria and a part of China, and it is a more robust plant, and its leaflets are thicker, lustrous, and narrower with a cuneate base, and with more acute serrations, and are often stipellate; its inflorescences are often large and dense; and its pedicels are short, and equal to or slightly longer than achenes. The presence or absence of stipellae is not a stable character, and intermediate forms between both extremes exist in Eurasia. Some specimens from continental Eastern Asia are similar to var. *brevipes* except for long pedicels which are 2-3-times longer than achenes, and they seem to be a form called as var. *affine* (Ledeb.) Regel or var. *amurense* Maxim.

**Trautvetteria japonica** Sieb. et Zucc. .... **T. grandis** Nuttall

Amur, Ochotsk, Saghalien, Yezo, Vancouver Is., south to Idaho,  
s. Kuril., n. & c. Honshu (mts.) Calif. & New Mexico

(2n=16)

**T. caroliniensis** (Walt.) Vail

Missouri to s. w. Penn. & n. w.  
Florida (2n=16)

The Eastern Asiatic plant, *T. japonica*, is more closely related to *T. grandis* of western N. America than to *T. caroliniensis* of eastern N. America. *T. caroliniensis* differs from *T. japonica* by deeply cleft thicker leaves which have obtuse sinus, and elevated veins on the lower side and are generally hairy beneath, and roundish achenes with short hooked beaks. *T. grandis* has thinner leaves which have acute sinus and are hairy on veins beneath, and slightly elongate achenes with long beaks curved at the apex.

*T. japonica* agrees with *T. grandis* in essential characters, but tends to have more deeply cut glabrous leaves, longer peduncles and slightly larger flat achenes. Var. *borealis* Hara with leaves hairy on veins beneath seems not to be a good geographical race, and some specimens from Saghalien and Primorskaja have glabrous leaves and some from Amur have leaves slightly hairy beneath. The Eastern Asiatic plant might better be treated as *T. grandis* var. *japonica*.

Lit. Hara in Bot. Mag. Tokyo 49: 14 (1935).

**Caulophyllum robustum** Maxim. ... **C. thalictroides** (L.) Michx.

Amur, Ussuri, Manch., China, Korea, s.e. Manitoba to New Brun-  
Saghal., Yezo, Honshu, Shikoku, swick, Nova Scotia, south to  
Kyushu (2n=16) Missouri, Tenn. & S. Carolina

(mts.) (2n=16)

Lit. Hara in Bot. Mag. Tokyo 49: 16 (1935); Fedtschenko in Fl. URSS. 7: 552 (1937).

**Chelidonium majus** L. ————— *C. majus*

Europe (2n=12), Caucasus, Asia Minor, e. C. Asia, s. Siberia  
n. Africa subsp. **asiaticum** Hara

Ussuri, Manch., China, Korea, Saghal., Yezo,  
Honshu, Shikoku, Kyushu (2n=10)

Compared with the European *C. majus*, the Japanese plant has a tendency to have smaller tender and more incised leaf-lobes, petals 8-16 mm long, slender filiform filaments with smaller anthers, more distinct stigmas, and ovaries with numerous 60-200 ovules, but its pollen-grains are about 70% sterile and its ovules also about 80% sterile. Its chromosomes are always  $2n=10$  in number, and form a ring in the meiotic division instead of regular pairing observed in *C. majus*. So I regard it as subsp. *asiaticum*, a separate genetic and geographical race from the European *C. majus*. All specimens from China, Korea, Manchuria, Ussuri and Saghalien, so far as I have examined, have many abortive pollen-grains and seeds as in the Japanese one, and seem to belong to subsp. *asiaticum*.

Var. *grandiflorum* DC. from Dahuria and north Mongolia is said to have longer pedicels 5-10 cm long, broader ovate bracteoles, and shorter capsules, but I have no chance to examine it.

If var. *grandiflorum*, as Prain has supposed, is a truly wild form of this species, it is probable that its chromosome number is  $2n=12$ . And subsp. *asiaticum* is a structural hybrid presumably derived from var. *grandiflorum*, a putative origin of the species, and spreads eastwards to the Far East. While the typical *C. majus* with normal chromosomes may also be derived from var. *grandiflorum*, and is migrated westwards to Europe in a recent age partly aided by human power, and such slight variations as var. *tenuifolium* Liljeblad (var. *laciniatum* (Miller) Koch), and var. *fumariifolium* Rouy et Fouc. are also observed in Europe.

Lit. Prain in Bull. Herb. Boiss. 3: 576 (1895); Fedde in Engl., Pfl.-reich IV-104, Ht. 40: 212 (1909); Busch in Fl. Sibir. Or.-Extr. 1: 10 (1913); Hara in Journ. Jap. Bot. 23: 43 (1949).

**Arabisopsis Thaliana** (L.) Heynhold — *A. Thaliana*

Europe ( $2n=(6), 10$ ), Caucasus, C. Asia, w. Siberia, Persia,  
Africa Himalaya, Mongolia, China, Korea, Yezo,  
Honshu, Shikoku, Kyushu

Lit. O.E. Schulz in Engl., Pfl.-reich IV-105, Ht. 86: 270 (1924); Busch in Fl. Sibir. Or.-Extr. 4: 415 (1926).

**Arabis glabra** (L.) Bernh. — *A. glabra* — *A. glabra*

(*Turritis glabra* L.) C. Asia, Himalaya, Siberia (east to Amur, s. Alaska to Quebec,  
Europe ( $2n=16, 32$ ), Ussuri), Manch., Korea, Saghal., s. Kuril., south to Calif., Illinois,  
Asia Minor, Caucasus Yezo, Honshu, Shikoku, Kyushu & N. Carolina

**A. lyrata** L.

n. Alberta, Minnesota, Ontario  
to Vermont, south to Missouri  
& n. Georgia ( $2n=16$ )

*Arabis lyrata*

var. *kamchatica* Fischer — var. *kamchatica*

(subsp. *kamtschatica* (Fisch.) Hultén, (var. *occidentalis* Watson,

*A. kamchatica* (Fisch.) Ledeb.) var. *glabra* (DC.) Hopkins)

Ochotsk, Kamt., Chukch, n. Korea Aleut., Alaska to Saskatchewan,  
(alp.), Saghal., Kuril., Yezo, Honshu, south to n. Washington & n.  
Shikoku (mts.) Montana

Lit. Busch in Fl. Sibir. Or.-Extr. 4: 466 (1926); Hultén, Fl. Kamt. 2: 165 (1928); Rollins in Rhodora 43: 360 (1941).

**Arabis pendula** L. ————— *A. pendula*

e. Europe, C. Asia, Siberia (east to Ussuri, Ochotsk, Kamt.),  
Mongolia, China, Manch., Korea, Saghal.,  
s. Kuril., Yezo, n. & c. Honshu

Lit. Busch in Fl. Sibir. Or.-Extr. 4: 434 (1926).

**Cardamine impatiens** L. ————— *C. impatiens*

Europe (2n=16), Caucasus, Siberia (Yenisei, Sajon) [Ochotsk, Ussuri],  
Persia, C. Asia, Himalaya, China, Korea,  
Saghal., s. Kuril., Yezo south to Ryukyu

Var. *eriocarpa* DC. with hairy siliquae is sometimes found in Japan.

Lit. O. E. Schulz in Engl., Bot. Jahrb. 32: 455 (1903); Busch in Fl. Sibir. Or.-Extr. 2: 242 (1915).

**Cardamine scutata** Thunb. ————— *C. scutata* ————— *C. scutata*

subsp. <b>flexuosa</b> (With.) Hara <sup>14)</sup>	subsp. <i>flexuosa</i>	subsp. <i>flexuosa</i>
( <i>C. flexuosa</i> Withering)	Asia Minor, Himalaya, China, Korea, [Newfld. to Quebec	
Europe (2n=32)	Saghal., Yezo south to Formosa]	
	subsp. <b>fallax</b> (O. E. Schulz) Hara <sup>14)</sup>	
	China, Manch., Korea, Honshu, Kyushu	
	subsp. <b>Regeliana</b> (Miq.) Hara <sup>14)</sup>	
	Ussuri, Ochotsk, Kamt., Korea, w. Aleut.,	
	Saghal., Kuril., Yezo south to Kyushu	

This plant is very common in rice-fields and wet places of Japan, and is exceedingly polymorphic. Some Japanese plants are hardly separable from European *C. flexuosa* in outer morphological characters.

A flaccid form, var. *latifolia* (Maxim.)<sup>14)</sup>, with green glabrescent sometimes

14) *Cardamine scutata* Thunberg in Trans. Linn. Soc. Lond. 2: 339 (1794).

subsp. **flexuosa** (With.) Hara, comb. nov. — *C. flexuosa* Withering, Arrang. Brit. Pl. ed. 3, 3: 578 (1796). *C. hirsuta* subsp. *flexuosa* (With.) Forbes et Hemsley in Journ. Linn. Soc. 23: 43 (1886).

var. **latifolia** (Maxim.) Hara, comb. nov. — *C. hirsuta* var. *latifolia* Maxim. in Bull. Acad. Sci. St.-Pét. 18: 279 in textu (1873). *C. hirsuta* var. *aquatica* O. Kuntze, Rev. Gen. Pl. 1: 22 (1891). *C. flexuosa* subsp. *debilis* (D. Don) et var. *occulta* (Hornem.) O. E. Schulz in Engl., Bot. Jahrb. 32: 478, 479 (1903), saltem pro parte.

subsp. **fallax** (O. E. Schulz) Hara, comb. nov. — *C. flexuosa* subsp. *fallax* O. E. Schulz in Engl., Bot. Jahrb. 32: 478 (1903), cum f. *microphylla*. *C. fallax* (O. E. Schulz) Nakai, Rep. Veg. Dagelet Is. 19 (1919); in Journ. Jap. Bot. 18: 285 (1942).

subsp. **Regeliana** (Miq.) Hara, comb. nov. — *C. angulata* Hook. var. *kamtschatica* Regel in Bull. Soc. Nat. Moscou 34-2: 172, t. 5, f. 1, 2 (1861). *C. Regeliana* Miquel, Ann. Mus. Lugd.-Bat. 2: 73 (1865). *C. flexuosa* subsp. *Regeliana* (Miq.) Schulz, l. c. 476 (1903).



caespitose stems, fewer larger leaflets, slightly thicker siliquae and shorter styles, is generally found along streams and ditches. Some have upper leaves with broad leaflets, and often become perennial.

In rice-fields of Japan, on the contrary, there occurs abundantly a dwarf form with flexuose purpurascens stems often branched and pilose in the lower part, many small leaflets, narrower siliquae, and slender styles 0.7-1 mm long. This seems to be uncommon in other regions, and Schulz included it in his subsp. *fallax*.

Subsp. *fallax*, however, is a distinct race which has erect stiff stems pilose to the upper part, lower leaves with small roundish leaflets distinctly petiolulated and 2-8 mm long, middle leaves with 4-8-pairs of subequal leaflets, and upper leaves with small linear leaflets. It grows in dryish habitats and looks very much alike to *C. impatiens* in general appearance. As Schulz did not designate the type specimen, I select the specimen collected at Simoda by C. Wright as the type of his subsp. *fallax* to avoid future confusion.

*C. Regeliana* in its typical form is distinguished from *C. flexuosa* in having glabrescent stems, upper leaves larger than the basal with a very large terminal leaflet 1-3 cm long and few (1-3-pairs) small lateral ones, and short stout styles 0.3-0.5 mm long. It often occurs along streams or wet cliffs on hills and mountains. The differences pointed out by N. Busch in Fl. URSS. 8: 161 (1939) are inconstant. The plants in northern regions or on higher mountains have often larger flowers.

It should be noted that *C. scutata* Thunberg is the correct name to cover all forms above mentioned, but I am not certain if *C. scutata* is an extreme form with reduced leaflets of subsp. *flexuosa* or subsp. *Regeliana*. All records of *C. hirsuta* L. and *C. parviflora* L. from Japan are doubtful.

Lit. Maxim. in Bull. Acad. Sci. St.-Pét. 18: 278 (1873); O. E. Schulz in Engler, Bot. Jahrb. 32: 473 (1903).

<b>Cochlearia officinalis</b> L.	- - - - -	<i>C. officinalis</i>	-----	<i>C. officinalis</i>
Atlantic & c. (mt.) Europe	subsp. <b>oblongifolia</b> (DC.) Hultén		subsp. <i>oblongifolia</i>	
(2n=24, 28)]	( <i>C. oblongifolia</i> DC.)		Aleut., Alaska to Oregon	
	(Ussuri, Ochotsk, Kamt., Chukch,			
	Saghal., Kuril., e. Yezo (2n=14)			
subsp. <b>arctica</b> (Schl.) Hultén	-----	subsp. <i>arctica</i>	-----	subsp. <i>arctica</i>
( <i>C. arctica</i> Schlecht.)				Alaska to Labrador;
arctic Europe (2n=14),	arctic Siberia (east to n. Kamt., Chukch)			Greenland; allied species in e. N. America.

Lit. Busch in Fl. Sibir. et Or.-Extr. 1: 121 (1913), in Fl. URSS. 8: 569 (1939); Hultén, Fl. Kamt. 2: 146 (1928), Fl. Alaska 5: 815 (1945); Polunin, Bot. Canad. East. Arc. 1: 225 (1940).

<b>Draba nemorosa</b> L.	-----	<i>D. nemorosa</i>	-----	<i>D. nemorosa</i>
Europe, Caucasus, Siberia (east to Ussuri, Kamt.), C. Asia,				Alaska to Hudson Bay, Ontario,
				Mongolia, China, Manch., Korea, south to Calif., Colorado &
				Yezo, Honshu, Shikoku, Kyushu
				Michigan

This species is common and weedy in Japan, but var. *lejocarpa* Lindblom with glabrous siliquae is extremely rare, while the latter is common in Manchuria and is the only race in Kamtchatka and Alaska.

Lit. Busch, Fl. Sibir. Or.-Extr. 3: 387 (1919), 4: 393 (1926); Pohle in Fedde, Rep. Beih. 32: 3 (1925); O. E. Schulz in Engl., Fl.-reich IV-105, Ht. 89: 309 (1927); Fernald in Rhodora 36: 365 (1934).

### **Rorippa islandica**

(Oeder ex Murray) Borbás — *R. islandica* ————— *R. islandica*  
*(R. palustris* (Leyss.) Besser) Aleut., Alaska to Nova Scotia, south,  
 Europe (2n=16, 32), Caucasus, Siberia, Asia Minor, to Michigan & Pennsylv. (nat?);  
 n. Africa C. Asia, India, Australia (intr.?) Greenland  
 var. **Fernaldiana** Butt. & Abbe ————— var. *Fernaldiana*  
 Amur, Ussuri, China, Manch., Mackenzie, British Columbia to s.  
 Korea, Saghal., Kuril, Yezo, Labrador, south to Calif., Mexico,  
 south to Kyushu Texas & Virginia  
 var. **hispida** (Desv.) Butt. & Abbe — var. *hispida*  
 e. Siberia (east to Ussuri, (*R. hispida* (Desv.) Britt.)  
 Kamt.), Saghal., Kuril. Alaska to Newfld., south to Calif.,  
 Arizona & Florida; West Indies.  
 Other varieties in western N. America.

Most of the Japanese plant agrees, as Fernald has pointed out, with var. *Fernaldiana* having less dissected upper and middle leaves, and slightly shorter siliquae than the typical *R. islandica*, but some specimens approach to the European form. This species is often found on cultivated grounds in Japan, and it may partly be introduced.

Lit. Fernald in Rhodora 30: 131 (1928), 42: 267 (1940), 50: 100 (1948); Marie-Victorin in Contr. Lab. Bot. Univ. Montréal 17: 12 (1930); Hara in Journ. Jap. Bot. 12: 342 (1936); Butters et Abbe in Rhodora 42: 25 (1940); Hultén, Fl. Alaska 5: 827 (1945).

### **Drosera anglica** Hudson em. Smith — *D. anglica* ————— *D. anglica*

Europe (2n=40), Siberia (east to Dahuria) [Amur, Ussuri, Kamt.), s. Alaska, Great Bear  
 Mongolia, Manch. (lake Hanka), n. Korea Lake to s. Labrador,  
 (isol.), Saghal., s. Kuril, Yezo] [c. Honshu south to n. Calif. (mts.),  
 (Oze, 2n=40) Idaho, n. Michigan &  
 Quebec

In the Japanese specimens, leaf-blades attain to 1.5-4 cm long 2-3.5 mm wide, and petioles to 3-9 cm long. The F<sub>1</sub> hybrid between this species and *D. rotundifolia*, i.e. *D. obovata* Mert. et Koch, occurs in Japan too, but its leaf-blades are 1-2.3 cm long 3-5 (5) mm wide, and are narrower than those of the same hybrid in Europe, and rather agree with those of some specimens of *D. anglica* in Europe and North America. So it seems probable that the parent species in Japan slightly differ cytologically from the European, although the chromosome-numbers are the same.

Lit. Diels in Engl., Pfl.-reich IV-112, Ht. 26: 96 (1936); Hara in Bot. Mag. Tokyo 64: 77, map 2 (1951).

**Drosera rotundifolia** L. ————— **D. rotundifolia** ————— **D. rotundifolia**  
 Europe (2n=20), Caucasus, Siberia (east to Amur, Ussuri, Kamt.), Alaska to s. Labrador,  
 China, Manch., Korea, Saghal., Kuril., south to Calif., Ill. & n.  
 Yezo, Honshu (2n=20), Shikoku, Florida; s. w. Greenland  
 Kyushu

**Penthorum chinense** Pursh ..... **P. sedoides** L.  
 (*P. sedoides* var. *chinense* (Pursh) Maxim.) [Minn. to New Brun-  
 Ussuri, Manchuria, China (2n=16), Tonkin, swick, south to Texas  
 Korea, Honshu, Shikoku, Kyushu] & Florida (2n=18)

The Eastern Asiatic plant has narrower leaves 4-15 mm wide, and shorter and thicker styles than the Eastern American one. *P. intermedium* Turcz. and *P. humile* Regel et Maack seem to me to be conspecific with *P. chinense*.  
 Lit. Borissova in Fl. URSS. 9: 132 (1939); Baldwin & Speese in Rhodora 53: 89 (1951).

**Rhodiola Rosea** L. ————— **R. Rosea** ————— **R. Rosea**  
 (*Sedum Rosea* (L.) Scop.) Alaska to Labrador, c.  
 Europe (2n=22), C. Asia, Siberia (Altai, Dahuria, east to Ochotsk, Baffin, south to New  
 Kamt., Chukch), Himalaya?, Kuril., Mexico, Minn., Pennsylv.  
 Yezo, n. & c. Honshu (alp.) (2n=22) & N. Carolina (mts.),  
 var. *oblonga* (Reg. et Til.) Hara with several varieties;  
 (*S. elongatum* Ledeb., *R. sachalinensis* A. Bor.)  
 e. Siberia (east to Ussuri, Ochotsk,  
 Kamt.), Saghal., n. China, Manch., n.  
 Korea, n. Yezo  
 subsp. *integrifolia* (Raf.) ————— subsp. *integrifolia*  
 (*S. atropurpureum* Turcz.) (*Rhodiola integrifolia* Rafin.)  
 e. Siberia (Lena to Chukch, Ochotsk, e. Aleut., Alaska to Alberta,  
 Uds., Kamt.), n. Kuril., w. China south to Calif. & Colorado

This plant is variable especially in the shape and serration of leaves in Japan, and also in Europe and North America.

The Japanese plants have always yellowish flowers. And those on high mountains of Honshu having glaucous obovate leaves, i.e. var. *Tachiroei* (Fr. et Sav.) Hara, closely resemble the typical European ones. Although the Japanese plants have sometimes more slender styles, it is difficult to distinguish the Eastern Asiatic races from the European by the shape of stigmas. A race, var. *oblonga* (Regel et Tiling) Hara, with oblong or oblanceolate and less glaucous leaves prevails in continental Eastern Asia including Saghalien and northernmost Yezo.

*R. Ishidae* (Miyabe et Kudo) Hara which is identical to *R. Stephani* (Cham.) Trautv. et Meyer according to Nakai, is a distinct plant which has narrow yellowish green and not glaucous leaves with the narrow cuneate base, distinct serration and cartilaginous-scabrous margin, and has follicles with a straight erect beak.



Lit. Rose in N. Amer. Fl. 22-1: 57 (1905); Hara in Journ. Jap. Bot. 13: 927, fig. (1937); Nakai in Journ. Jap. Bot. 14: 491 (1938); A. Borissova in Fl. URSS. 9: 29 (1939); Hultén, Fl. Alaska 5: 895 (1945).

**Sedum purpureum** (L.) Schult. — *S. purpureum* ..... **S. telephioides** Michx.  
 (*S. Telephium* L. subsp. *purpureum* (L.) Schinz et Keller) Illinois to w. New York.  
 Europe (2n=36), Siberia (east to Ussuri, Ochotsk, Kamt.), Mongol., south to Georgia  
 China, Manch., n. Korea, Saghal., Kuril,  
 Yezo  
**S. alboroseum** Baker  
 (*S. Okuyamae* Ohwi)  
 China?, Korea, Honshu, Kyushu (2n=48, 50)

The *Sedum Telephium* group is exceedingly polymorphic morphologically and also cytogenetically in Eastern Asia. Its classification and nomenclature are very confused, and a critical study of the group is much needed.

In Japan we can recognize at least three distinct races, i.e. *S. purpureum* Schultes, *S. alboroseum* Baker and *S. verticillatum* L.

*S. purpureum* occurs in northern Japan generally near the coast. It has carrot-like or fusiform tuberous roots, rubescent stems, alternate or opposite dark green leaves which are nearly sessile and roundish or cuneate at the base, and are irregularly but distinctly dentate, roundish compact inflorescences, dark reddish flowers, sepals 1.5–3 mm long, short nectariferous scales about twice as long as broad, and dark reddish pistils 3.5–4.5 mm long.

While *S. alboroseum* in the mountain region of Honshu, although pretty variable, has green or rubescent stems, alternate or opposite or rarely ternate and slightly glaucous often bluish green leaves which are narrowed to a short petiole, concave and often ascending, and are almost entire or minutely crenate-dentate, whitish or reddish flowers 8–13 mm in diameter, sepals 1–2 mm long, scales up to 1 mm long and 2–4-times as long as broad, greenish or reddish pistils 4–5.5 mm long. So far as I know, its roots are slender and not tuberous as in *S. purpureum*.

A garden-form of *S. alboroseum* has generally glaucous bluish green ascending leaves, flat-topped inflorescences, whitish petals and pink pistils, and it has no normal pollen, and its chromosomes show very irregular meiotic division. But I think, it is included within the variations of wild plant of Honshu which has erroneously been referred to *S. Telephium* var. *purpureum* by Makino since 1897. *S. erythrostictum* Miquel may be conspecific, although it seems to have smaller flowers according to the original description.

*S. alboroseum* alike *S. Sieboldii* Sweet has long been cultivated in Japan, but is recently replaced mostly by more handsome *S. spectabile* Boreau of Manchuria and China.

Lit. Praeger in Journ. Roy. Hort. Soc. 46: 82 (1921); Fröderström in Act. Hort. Gothob. 5: app. 61 (1930); A Borissova in Fl. URSS. 9: 53 (1939).

- Tillaea aquatica** L. ————— *T. aquatica* ————— *T. aquatica*  
 n. & c. Europe (east to w. [Ussuri, Korea, s. Kuriles, [Washington, Utah & Minn.,  
 Russia]) Yezo, Honshu] south to Mexico & Louisiana]  
 n. Africa? [Newfld., south to Maryland  
 Lit. Hara in Bot. Mag. Tokyo 49: 77 (1935); Borissova in Fl. URSS. 9: 12 (1939).

- Chrysosplenium** ————— *C. alternifolium* ————— *C. alternifolium*  
*alternifolium* L. var. *sibiricum* Seringe ————— var. *sibiricum*  
 Europe (2n=48), Siberia (east to Amur, Kamt.), n. Mongol., (*C. iowense* Rydb.)  
 Caucasus, Siberia? n. China, Manch., Saghal., s. Kuril., n. e. arctic Canada; Alberta]  
 Yezo [n.e. Iowa (isol.)  
**C. tetrandrum** (Lund.) Th. Fries — *C. tetrandrum* ————— *C. tetrandrum*  
 (*C. alternifolium* subsp. *tetrandrum* (Fr.) Hultén) Alaska, arctic Canada, Labrador,  
 arctic Europe (2n=24), arctic Siberia (east to Chukch) south to Washington & Hudson  
 Bay; Colorado; Greenland

The Eastern Asiatic plants, var. *sibiricum*, are more slender, and have smaller glabrescent and 5-7 (11)-crenate leaves, and smaller flowers 3-5 mm in diameter than the European *C. alternifolium*. It is remarkable that the same form as the Eastern Asiatic one occurs very isolated in North America.

The allied but distinct *C. japonicum* (Maxim.) Makino is widely distributed in Japan from southern Yezo to south Kyushu.

Lit. Hara in Nova Flora Japon. 3: 87 (1939), in Rhodora 51: 191 (1949); Rosendahl in Rhodora 49: 25 (1947).

- Mitella nuda** L. ————— *M. nuda*  
 Siberia (Yenisei, Sajan, east to [s. Alaska, Mackenzie, to s.  
 Ussuri, Ochotsk), Manch., n. Labrador, south to n. Washing-  
 Korea, Yezo] ton, Michigan & Pennsylv.

Lit. Hara in Nova Flora Japon. 3: 123 (1939).

- Parnassia palustris** L. ————— *P. palustris* ————— *P. palustris*  
 Europe (2n=18 (27, 54)), Siberia (east to Kamt., Chukch), Aleut., Alaska  
 Caucasus, C. Asia, Asia Minor, Persia, Himalaya, var. *neogaea* Fernald  
 n. Africa Mongolia, n. China, Manch., (subsp. *neogaea* (Fern.)  
 Korea, Saghal., Kuril., Yezo, Hon- Hultén)  
 shu (2n=18), Shikoku, Kyushu, Alaska to s. Labrador,  
 Formosa (mts.) south to n. Michigan &  
 n. w. Newfld. (2n=36)  
 var. *tenuis* Wahlenb. ————— var. *tenuis*  
 n. Europe (2n=36) (? *P. obtusiflora* Rupr.) var. *californica* A. Gray  
 n. Siberia (2n=36) Oregon to Calif.

This species which is common in Japan from lowlands to alpine regions is very variable, but it is impossible to draw lines of demarcation between the races of Japanese plants, and it is difficult to note even the local tendency of their variation.

Some Japanese specimens are inseparable from European ones by outer morphological characters. But a few specimens from northern Japan have acutish cauline leaves, longer sepals, acutish petals with fewer nerves, and

staminodia with broader claws, and thus approach to var. *neogaea* Fernald of North America. Others have rounded petals with fewer nerves, and staminodia with broad claws. The size of flowers and the number of setae of staminodia are highly variable. Some from alpine regions come near to var. *tenuis* Wahl., while a robust form which has been referred to var. *multiseta* Ledeb. having larger flowers and staminodia with many about 20 setae and narrow claws, is common on lowlands. Specimens from southern Japan also have sometimes acutish cauline leaves, larger sepals, and petals with fewer nerves.

Lit. Nakai in Bot. Mag. Tokyo 40: 469 (1926); Fernald in Rhodora 39: 310 (1937); Erlandsson in Act. Hort. Bergian. 13: 117 (1942); Hultén, Fl. Alaska 5: 954 (1945), 10: 1751 (1950); Löve in Bot. Notis. 1950: 40.

**Ribes triste** Pallas ————— *R. triste*

n. & e. Siberia (arctic Siberia, Dahuria	Alaska, Mackenzie, to s. La-
to Ussuri, Ochotsk, Kamt., Chukch),	brador, south to Oregon, S.
n. Korea, Saghal., Yezo	Dakota, Michigan, W. Virginia
	& New Jersey

Lit. Fernald in Rhodora 9: 3 (1907); Pojarkova in Acta Acad. Sci. URSS. ser. 1, 2: 162 (1936).

**Saxifraga bronchialis** L. — *S. bronchialis*

Urals, Siberia (east to Ussuri, Ochotsk, n. Kamt.) (2n=ca.

150), n. Mongolia, Manch.

*S. bronchialis*

subsp. **Funstonii** (Small) Hultén ————— subsp. *Funstonii*

arctic Siberia (east to Ochotsk,	w. & e. Aleut., Alaska, Yukon
Kamt., Chukch), Saghal., n. Kuril.	subsp. <b>austromontana</b>

var. <b>rebunshirensis</b> (Engl. et	(Wieg.) Piper
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Irms.) Hara	British Columbia, Alberta, to
Saghal., Kuriles, Yezo (2n=48), n.	Oregon, Utah & New Mexico
& c. Honshu (alp.)	

The Japanese plant is easily separable from the typical *S. bronchialis* in having broader more or less spatulate leaves with a very short spinule 0.3-1 mm long at the apex. Although it is variable, the common Japanese race, i.e. var. *rebunshirensis*, agrees well with subsp. *Funstonii* except for its petals which are red-spotted in the upper part, and are clawless and slightly narrowed at the base. Var. *cherlerioides* (D. Don) Engler having very dense incurved leaves and smaller flowers with yellow spots only, occurs in northern Kuriles and Saghalien, and forms approaching to it are also found on high mountains of central Honshu. Specimens from central Honshu tend to have narrower leaves and acutish petals than the northern ones, and var. *togaku-shensis* Hara is an extreme form having narrow leaves with longer marginal hairs. A form having petals with yellow spots only is rarely observed in Japan too, and on the contrary, Hultén described var. *purpureomaculata* from west Alaska. So I think, it is evident that the Japanese plant belongs to the



same race as *S. cherlerioides*, *S. Funstonii* and also *S. firma* Litwinov. When they are regarded as a separate species from *S. bronchialis*, the oldest name is *S. cherlerioides* D. Don as I adopted in 1939.

Subsp. *austromontana* of the Rocky mountains has lanceolate (not spathulate) acute leaves with regular short ciliae and shorter styles, compared with the Japanese plant.

Lit. Hultén, Fl. Kamt. 3: 12 (1929), Fl. Alaska 5: 906 (1945); Hara in Journ. Jap. Bot. 13: 174 (1937), in Nova Fl. Japon. 3: 58 (1939); Losina-Losinskaja in Fl. URSS. 9: 180 (1939).

<i>Saxifraga cernua</i> L.	<i>S. cernua</i>	<i>S. cernua</i>
n. & c. (mts.) Europe (2n=50, ca. 60, 66)	Siberia (east to Ochotsk, Kamt, Chukch), Tienschan, Himalaya, n. China, Saghal.] [c. Honshu (alp.)	Alaska, arctic Canada to Labrador, south to Wash- ington, New Mexico (alp.), Minnesota & Quebec; Gre- enland

It is remarkable that this species occurs quite isolated in the alpine regions of central Honshu.

Lit. Engler et Irmscher in Engl., Pfl.-reich IV-117-1, Ht. 67: 270 (1916); Hara in Nova Fl. Japon. 3: 52 (1939).

<i>Saxifraga punctata</i> L.	<i>S. punctata</i>	
n. e. Russia (Pechora R., Urals), Siberia (east to Ussuri, Kamt., Chukch), n. Mongol., n. Korea (alp.)		<i>S. punctata</i>
subsp. <i>Nelsoniana</i> (D. Don) Hultén	arctic Siberia (east in Kamt., Chukch)	subsp. <i>Nelsoniana</i> Alaska, Yukon
subsp. <i>insularis</i> Hultén	s. Kamt., n. Kuril., c. Yezo (alp.)	subsp. <i>insularis</i> Aleut., Behring Sea distr.
subsp. <i>reniformis</i> (Ohwi) Hara ( <i>S. reniformis</i> Ohwi)	Saghal., n. Yezo (Mt. Rishiri)	subsp. <i>pacifica</i> Hultén e. Aleut., Alaska to Alberta, south to Oregon; some other races in western N. America.

Subsp. *reniformis* of Saghalien and Is. Rishiri of north Yezo has glabrous leaves, pedicels with soft hairs, white petals about 3 mm long, clavate narrow oblanceolate filaments, greenish capsules 4-5 mm long with divaricate beaks, and discoid stigmas.

It is closely allied to subsp. *insularis* which in the typical form from Aleutians, has more compact inflorescences, often larger and dark purplish petals, narrow linear filaments, and larger dark purplish follicles 6-8 mm long with less divaricate beaks. The plant of northern Kuriles has white petals, but agrees well with some Aleutian specimens.

It is noteworthy that the plant isolated in the alpine region of central Yezo shows somewhat intermediate characters. It differs slightly from subsp. *insularis* in having white smaller flowers, less hairy inflorescences, and follicles with divaricate beaks, and also from subsp. *reniformis* only in having less

clavate linear filaments, and small less hairy inflorescences.

Subsp. *reniformis* is near also to subsp. *pacifica* of western North America, and the differences between the races are sometimes not very clear.

On high mountains of north Korea, a quite distinct race which has been considered as the typical *S. punctata* occurs. It has hairy leaves, loose inflorescences, long capillary spreading pedicels with stipitate glands in the lower part, distinctly clavate oblanceolate filaments, follicles (4) 6-8 mm long, and punctate stigmas.

Lit. Engler et Irmscher in Engl., Pfl.-reich IV-117-1, Ht. 67: 9 (1916); Hultén, Fl. Kamt. 3: 25 (1929), in Svensk Bot. Tidskr. 30: 524 (1936), Fl. Alaska 5: 928 (1945); Ohwi in Act. Phytotax. et Geobot. 2: 25 (1933); Hara in Nova Fl. Japon. 3: 69 (1939).

<b><i>Acomastylis calthifolia</i></b> (Smith) Bolle	—	<b><i>A. calthifolia</i></b>
( <i>Geum calthifolium</i> Menzies ex Smith)		Aleut., Alaska, south to
Kuril., s. Kamtchatka		British Columbia
var. <b><i>nipponica</i></b> (Bolle) Hara		
Kuril., Yezo (2n=42), n. & c. Honshu		
(alp.), Shikoku (alp.)		

The plants of Honshu have generally less hairy leaves with unequal coarse teeth, and styles pilose in the lower part, while the typical *A. calthifolia* of western North America has leaves with small teeth and styles pilose near to the top. Intermediate forms, however, are often found in Yezo, Kuriles and Aleutians, and the two races cannot be separated specifically. Some specimens from Yezo have leaves with small teeth like the American, but have styles pilose only on the lower half. The plants of Kuriles tend to have thicker and more densely hairy leaves than the Japanese ones.

Lit. Bolle in Fedde, Rep. Beih. 72: 81 (1933); Hara in Journ. Jap. Bot. 12: 137 (1936).

<b><i>Aruncus silvester</i></b> Kostel. ex Maxim.	—	<b><i>A. silvester</i></b>	—	<b><i>A. silvester</i></b>
c. Europe (mts.) (2n=14, 18), Caucasus, Siberia (east to				Aleut., Alaska, south to n.
Ussuri, Ochotsk, Kamt., Chukch),				California
Persia, C. Asia, Himalaya, Mongolia,				<b><i>A. dioicus</i></b> (Walter) Fernald
China, Korea, Saghal., Kuril., Yezo,				& var. <b><i>pubescens</i></b> (Ryd.) Fern.
Honshu, Shikoku, Kyushu (mts.)				Iowa to New York, south to
				Oklahoma & Georgia

I agree with Fernald and Hultén in referring polymorphic Asiatic plants to *A. silvester*.

Although it is difficult to find constant characters separating them into distinct races, the Japanese plants tend to have thinner elongate leaflets with a longer caudate apex, loosely-flowered male inflorescences, smaller petals less than 1 mm long and particularly small in female flowers, and generally smaller follicles about 2 mm long, and its extreme form is var. *tenuifolius* Nakai ex Hara on mountains of Shikoku and Kyushu.

To the north, they pass into plants with broader leaflets with a short-

caudate apex, dense inflorescences, and larger flowers, i. e. *A. asiaticus* Pojark. which is represented by specimens from Saghalien, and also into var. *kamtchaticus* Maxim. with small compact inflorescences, which occurs in Kuriles in its typical form. The common form in Honshu shows intermediate characters, and has dense inflorescences with smaller flowers and long-caudate leaflets than the European.

Sometimes forms with leaves densely pubescent beneath are found in Yezo (var. *tomentosus* Koidzumi), south Kuriles, and Saghalien.

Lit. Koidzumi in Journ. Coll. Sci. Tokyo Univ. 34-2: 26 (1913); Fernald in Rhodora 33: 179 (1936), 41: 423 (1939); Hara in Journ. Jap. Bot. 13: 386 (1937); Pojarkova in Fl. URSS. 9: 310 (1939); Hultén, Fl. Alaska 6: 985 (1946).

<i>Dryas octopetala</i> L.	<i>D. octopetala</i>	<i>D. octopetala</i>
n. & c. (mts.) Europe (2n=18)	Siberia (east to Kamt., Chukch), Mongolia; with several races	e. Aleut., Alaska; Greenland
subsp. <i>caucasica</i> (Juz.) Hultén	var. <i>asiatica</i> Nakai (subsp. <i>Tschonoskii</i> & <i>nervosa</i> (Juz.) Hultén)	subsp. <i>Hookeriana</i> (Juz.) Hultén
Caucasus	Ussuri?, n. Korea, Saghal., s. Kuriles, Yezo (alp.), c. Honshu (alp.)	Alaska, Yukon, south to Oregon, Utah & Colorado; with other races

Although this species is polymorphic, the plants above referred to var. *asiatica* are less variable. They have broad elliptic leaves 8-20 (25) mm long 5-16 mm wide with 5-9 (12) pairs of nerves which are elevated beneath, and petioles, midribs beneath, upper part of peduncles and calyces more or less have brown thick hairs with numerous long white ciliae.

Lit. Juzepczuk in Bull. Jard. Bot. Princ. URSS. 28: 306 (1929), in Fl. URSS. 10: 264 (1941); Nakai in Bot. Mag. Tokyo 46: 606 (1932); Hultén, Fl. Alaska 6: 1046 (1946); Porsild in Canad. Field Nat. 61: 175 (1947).

<i>Geum aleppicum</i> Jacquin	<i>G. aleppicum</i>	<i>G. aleppicum</i>
Europe (2n=42), Caucasus, C. Asia, Siberia (east to Amur, Kamt.), Mongol., Manch., China, Korea, Saghal., Kuriles, Yezo, n. & c. Honshu (2n=42)	var. <i>strictum</i> (Ait.) Fernald ( <i>G. strictum</i> Aiton)	British Columbia, s. Mackenzie, to Newfld., south to Calif., n. Mexico, Nebraska, Ohio & New Jersey

The Japanese plant well agrees with the European one. It has usually villose peduncles and sepals, body of achenes pilose with long hairs, and hairy stigmas. While the American var. *strictum* has inconspicuously pubescent peduncles, and sepals with very minute hairs and sometimes mixed with rough hairs, body of achenes short-pilose or glabrous, and stigmas with sparse hairs, and no Asiatic specimens match with the American ones. In var. *strictum*, basal leaves have a tendency to have incised and pointed segments, but the shape of radical leaves and the size of flowers are variable both in *G. aleppicum* and var. *strictum*.



Lit. Bolle in Fedde, Rep. Beih. 72: 56 (1933); Hara in Bot. Mag. Tokyo 49: 123 (1935); Fernald in Rhodora 37: 293 (1935).

<b>Geum macrophyllum</b> Willd.	————— <i>G. macrophyllum</i>
Kamt.?, n. Kuril?	Aleut., Alaska to s. e. Labrador,
var. <b>sachalinense</b> (Koidz.)	south to Calif., Wisconsin & New
Hara <sup>15)</sup>	York (mts.)
( <i>G. Fauriei</i> Lév., <i>G. sachalinense</i>	var. <b>perincisum</b> (Rydb.) Raup
(Koidz.) Mak.)	Alaska to Mackenzie, south to Calif.
s. Kuril., Saghalien, Yezo, n. &	& Arizona, Lake Superior (isol.)
c. Honshu (mts.)	

The American plant is variable especially in the shape and size of stipules, but the Japanese plant differs slightly from it in having always small ovate-lanceolate entire stipules (less than 1 cm long), peduncles generally more coarsely villose beneath long scattered bristles, and densely pubescent receptacles with longer coarse hairs. I am not certain if the type of *G. macrophyllum* based on specimens which were raised from seeds collected in Kamtchatka is identical with the American plant or with var. *sachalinense*<sup>15)</sup>.

Lit. Raup in Rhodora 33: 172 (1931); Bolle in Fedde, Rep. Beih. 72: 63 (1933); Hara in Journ. Jap. Bot. 14: 336 (1938).

<i>Potentilla Egedei</i>	<i>P. Egedei</i>	<b>P. Egedei</b> Wormsk.
var. <b>groenlandica</b> (Tratt.)	var. <i>groenlandica</i>	s. Baffin to Quebec; Greenland
Polunin	[e. Siberia (Chukch, Ochotsk)	Alaska to Labrador; Greenland
n. Europe (2n = 28, 35,	var. <b>grandis</b> (Torr. et Gr.) Hara <sup>16)</sup>	var. <i>grandis</i>
42)]	Kamt., Ochotsk, Ussuri, Manch.,	Aleut., Alaska, south to Calif.]
	Korea, Saghal., Kuril., Yezo, n.	[Labrador, south to Long
	Honshu (along coasts south to	Island
	Sado)	

The Japanese plant has usually oblong leaflets white-tomentose beneath and with 5-10 acutish teeth on each side, and calyces tomentose outside. Colonies with leaflets sericeous-tomentose on both sides are sometimes found in Saghalien.

Lit. Fernald in Rhodora 11: 1 (1909); Hultén, Fl. Kamt. 3: 63 (1929), Fl. Alaska 6: 1013 & 1024 (1946); Hara in Bot. Mag. Tokyo 49: 200 (1935); Polunin in Rhodora 41: 40 (1939); Juzepczuk in Fl. URSS. 10: 222 (1941); Erlandsson in Hereditas 28: 503 (1942); Boivin in Canad. Field.-Nat. 65: 21 (1951).

15) *Geum macrophyllum* Willd. var. **sachalinense** (Koidzumi) Hara, comb. nov. — *G. japonicum* var. *sachalinensis* Koidzumi in Bot. Mag. Tokyo 29: 157 (1915). *G. Fauriei* Lév. in Fedde, Rep. 8: 281 (1910).

16) *Potentilla Egedei* Wormsk. var. **grandis** (Torr. et Gray) Hara, comb. nov. — *P. Anserina* β. *grandis* Torrey et Gray, Fl. N. Amer. 1: 444 (1840). *P. pacifica* Howell, Fl. N.-W. Amer. 1: 179 (1898).

<i>Potentilla fruticosa</i> L.	<i>P. fruticosa</i>	<i>P. fruticosa</i>
Europe (2n=28), Caucasus, Asia Minor, Persia, C. Asia, Mongolia,		Alaska, Mackenzie, to
Siberia (east to Ochotsk, Kamt., Chukch)		s. Labrador, south to
var. <i>arbuscula</i> (D. Don) Maxim.		Calif., New Mexico,
China, Manch., n. Korea, Himalaya, Saghal.,		Ohio & n. New Jersey
Kuril, Yezo (alp.), Honshu (alp., 2n=14)		(2n=14)
var. <i>leucantha</i> Makino		
Dahuria?, Amur, n. Manch., n. & w. China,		
n. Korea, c. Honshu (alp.), Shikoku (alp.)		

Handel-Mazzetti referred the specimens from China, Himalaya and Japan to *P. arbuscula* D. Don, *P. parvifolia* Fischer and *P. glabra* Loddiges, but the differences between those species and *P. fruticosa* are not so clear as he stated, and I regard them all as geographical varieties of *P. fruticosa*.

In Japan, both yellow- and white-flowered races occur on high mountains. Although the shape and hairiness of leaves are variable in this polymorphic species, the Japanese plant has short broad flat (not revolute) often less sericeous leaflets 5-15 (18) mm long 2-7 mm wide, and generally broad herbaceous outer sepals.

Some specimens from Saghalien have glabrescent stems, leaves glabrescent at least on the under surface, and broad glabrescent calyx-lobes. The plants of central Honshu have adult leaves sparsely sericeous above and only on the midrib beneath or glabrescent, and the same form is found also in Yezo, Kuriles, Korea, Manchuria, and north China. A form with leaves densely sericeous on both sides occurs on Mt. Hayachine of north Honshu, and also rarely in Yezo and Kuriles.

A white-flowered race is found in the alpine region of the southern part of central Honshu, and also in Shikoku where it is the only race of this species. Specimens from Mt. Tsurugi of Shikoku have glabrescent leaves only sparsely sericeous above and on leaf-rhaches. Those of central Honshu including the type of var. *leucantha* Makino have leaves slightly more sericeous than those of Shikoku, but differ clearly from var. *mandshurica* Maxim. with leaves densely sericeous on both sides and with calyces also densely sericeous. Compared with the Japanese plants, the type specimen of var. *Veitchii* (Wilson) Bean from w. Hupeh has leaves slightly more sericeous on both sides with somewhat elevated veins beneath, and more sericeous calyx-lobes. These differences, however, seem to me to be so delicate and variable that I refer them except var. *mandshurica* to var. *leucantha* which is the earliest varietal epithet for these white-flowered races.

Lit. Hand.-Mzt., Symb. Sin. 7-3: 508 (1933), in Act. Hort. Gotob. 13: 289 (1939); Nakai in Journ. Jap. Bot. 15: 595 (1939); Juzepczuk in Fl. URSS. 10: 69 (1941).

<b>Potentilla nivea</b> L.	<b>P. nivea</b>	<b>P. nivea</b>
n. & c. (mts.) Europe (2n=56), Caucasus, Siberia (east to Ussuri, Ochotsk, Kamt.), n. Mongolia, n. China, Manch., n. Korea, Saghal., s. Kuril., Yezo (alp., 2n=70), c. Honshu (alp.)		British Columbia, arctic Canada, Labrador to Quebec; Colorado & Utah; Greenland

The *Potentilla nivea* group was divided into several species by the recent critical study of Hultén, and the Japanese plants are included in the true *P. nivea*. In temperate Eastern Asia, this species occurs isolated on high mountains, and is represented by minor forms slightly differentiated from each other morphologically and cytologically. To the map of distribution given by Hultén as fig. 6, Paiktu-shan Mts. of north Korea and Khingan Mts. of Manchuria should be added.

The plants in the alpine regions of central Honshu are rather uniform. They are middle-sized with flowering stems 8-20 cm high, and have obovate or roundish rarely elliptic leaflets which are green and often glabrescent above, and have generally short 3-6 teeth on both sides. While the plants from central Yezo are variable. Specimens from Mt. Yubari have often larger broad glabrescent leaflets with more coarse teeth and ovate broad sepals (var. *yuparensis* Miyabe et Tatewaki), and those from Sôunkyô have smaller elliptic leaflets thinly floccose above, and lanceolate narrow sepals. The Japanese plants only slightly differ from the European in outer morphological characters, but they probably belong to higher polyploids than the European.

The plants of Is. Shikotan have leaves densely sericeous above and decumbent stems, and some specimens from north Korea have also sericeous leaves, and may be referable to var. *tomentosa* Nilsson-Ehle ex Hultén.

Although I have examined only one specimen from Mt. Tosso of Saghalien, it is remarkable that the specimen has styles not thickened and not papillate at the base. A specimen from Mt. Hsiao-wutaishan in north China was cited under *P. nervosa* Juzepczuk by Hultén, and by him *P. nervosa* was distinguished from *P. nivea* in having linear styles without papillae at the base. A specimen from the same mountain in Herb. Univ. Tokyo, however, has styles distinctly verrucose in the lower part, and seems to me to belong also to *P. nivea*.

Lit. Hultén in Bot. Notis. 1945: 127, fig. 6 (1945).

<b>Potentilla norvegica</b> L.	<b>P. norvegica</b>	<b>P. norvegica</b>
n. & c. Europe (2n=70), Caucasus, Siberia (east to Ussuri, Kamt.), n. Mongolia, Korea, Saghal., Yezo		var. <i>hirsuta</i> (Michx.) Lehm. ( <i>P. monspeliensis</i> L.) Alaska to s. Labrador, south to Calif., Mexico & N. Carolina; Greenland (intr.?); with var. <i>labradorica</i> (Lehm.) Fernald.

The difference between the European and American races is not clear in outer morphological characters. I am not certain if the Japanese plant is really indigenous or introduced.

Lit. Hegi, Illust. Fl. Mitt.-Europ. 6-1: 856 (1923); Hultén, Fl. Alaska 6: 1022 (1946).



**Potentilla palustris** (L.) Scopoli — *P. palustris* ————— *P. palustris*  
 (*Comarum palustre* L.) e. Aleut., Alaska to Labrador,  
 Europe (2n=28, (42, 64)), Caucasus, Siberia (east to Ussuri, south to n. Calif., n. Indiana  
 Kamt., Chukch), n. Mongolia, Manch., & n. New Jersey; s. Greenland  
 ch., Korea, Saghal., Kuril., Yezo, n.  
 & c. Honshu

The Eastern Asiatic plant is not quite the same as the European one. In the common form of Japan, its stems are glabrous in the lower part; its stems and petioles appressed hairy only; its pedicels also appressed hairy intermixed with glandular hairs; its adult leaves nearly glabrous and green above; while the European plant has usually spreading and glandular hairs in the upper part of stems, and at least its pedicels are more or less spreadingly hairy mixed with many glandular hairs. The form identical with the Japanese, prevails in Eastern Asia and also in North America, but I hesitate to regard it as a geographical race, because a form with appressed hairy pedicels is rarely met with in Europe too. A more hairy form with greyish leaves densely sericeous above is sometimes found in Japan as well as in North America, and it has been referred to f. *subsericea* (W. Becker) Wolf, although I suspect if the typical f. *subsericea* is a pubescent form of Europe having pedicels with spreading hairs.

Lit. Fernald in *Rhodora* 16: 10 (1914).

**Rosa suavis** Willd. ————— *R. suavis* - - - - - *R. suavis* var.<sup>17)</sup>  
 (*R. acicularis* Lindl.) Alaska to s. Labrador,  
 n. Europe (2n=56), Siberia (east to Ussuri, Kamt., Anadyr), south to Utah, Colorado,  
 C. Asia, n. Mongolia, n. China, Manch., Minn. & Pennsylv.; with  
 Korea, Saghal., s. Kuril., Yezo (2n=53), several varieties (2n=42)  
 n. & c. Honshu (mts., rare)  
**R. nipponensis** Crepin  
 n. & c. Honshu (alp., 2n=14), Shikoku  
 (alp.)

The Japanese plant has leaves glabrous above, and hirsute generally on main nerves only and not very glaucous beneath, and glabrous calyces; its

17) **Rosa suavis** Willdenow, Enum. Pl. Hort. Berol. Suppl. 37 (1813).

*R. acicularis* Lindley, Rosac. Monogr. 44, t. 8 (1820).

var. **hypoleuca** (Mey.) Hara, comb. nov. — *R. acicularis* α. *hypoleuca* C. A. Meyer in Mém. Acad. Sci. St.-Pét. ser. 6, 6: 15 (1847).

var. **Gmelini** (Bunge) Hara, comb. nov. — *R. Gmelini* Bunge in Ledebour, Fl. Alt. 2: 228 (1829). *R. acicularis* β. *Gmelini* (Bunge) C. A. Meyer, l. c. 17 (1847).

var. **Bourgeauiana** (Crépin) Hara, comb. nov. — *R. acicularis* var. *Bourgeauiana* Crépin in Bull. Soc. Bot. Belg. 15: 29 (1876).

var. **Engelmannii** (Watson) Hara, comb. nov. — *R. Engelmannii* S. Watson in Gard. & For. 2: 376 (1889). *R. acicularis* var. *Engelmannii* Crepin ex Rehder in Bailey, Cycl. Amer. Hort. 1555 (1902).

pedicels are glabrous and densely glandular-setose, or smooth; and it is variable in the shape of leaflets and hips. It has often been referred to var. *Gmelini* (Bunge)<sup>17)</sup>, but the authentic specimen of the latter from Altai (Ledebour) has leaves hairy above and villose beneath, and smaller roundish leaflets.

*R. nipponensis* Crepin on high mountains of Honshu is more slender and glabrescent, and has smaller roundish leaflets with small numerous acuminate incurved teeth, glabrescent stipules and petioles, and glandular-setose or smooth pedicels. *R. nipponensis* which is often regarded as a variety of *R. suavis* is generally considered to be derived from the latter which is polymorphic and widely distributed, but it is remarkable that the latter is octaploid while the former is reported as diploid, and in this respect *R. nipponensis* as well as *R. rugosa* Thunb., *R. davurica* Pallas and *R. Marretii* Lév. retains the archaic character in this group.

The North American plants<sup>17)</sup> are also variable, and many specimens have leaves pubescent and glandular beneath, and they are hexaploid. The earliest specific name for the group seems to be *R. suavis* Willd., as pointed out by Nakai in 1936, and this group needs critical studies.

Lit. Erlanson in Pap. Michig. Acad. Sci. Arts & Lett. 5: 85 (1926), in Bot. Gaz. 96: 197 (1934); Hara in Bot. Mag. Tokyo 49: 201 (1935); Raup in Sargentia 6: 202 (1947).

<b>Rubus Chamaemorus</b> L. ——— <i>R. Chamaemorus</i> ——— <i>R. Chamaemorus</i>
n. & c. Europe (2n=56), Siberia (east to Ochotsk, Ussuri, Aleut., Alaska to Labrador, s. Kamt., Chukch), n. Manch. (rare), Buffin, south to w. British Columbia, Lake Superior, Maine & n. Korea, Saghal., n. & c. Kuril., New Hampshire (mts.), Long Yezo, n. Honshu (isol.) Is.; s. w. Greenland

<b>Rubus idaeus</b> L. ——— <i>R. idaeus</i> ——— <i>R. idaeus</i>
Europe (2n=14 (28, 42)), Caucasus, C. Asia, Siberia (east to Yenisei, Sajon) Minn. and Magdalen Is.
subsp. <b>melanolasius</b> Focke ——— subsp. <i>melanolasius</i>
Siberia (Urals to Ussuri, Ochotsk, (2n=28), n. Mongol., Alaska to s. Labrador, south to Kamt.) n. Manch., Korea, Saghal., s. Kuril., Oregon, Colorado, Michigan & Yezo, n. & c. Honshu (mts.) N. Carolina (mts.); several races
subsp. <b>nipponicus</b> Focke in western N. America
n. & c. Honshu (mts.)

The species is extremely variable especially in the shape of leaflets and calyx-lobes, and in the density of hairs, stipitate glands and prickles. It is apparent that geographical races different from the European one are present in Eastern Asia and North America, but it is difficult to draw distinct lines of demarcation between them, as parallel variations are observed in different regions.

The most common race in Eastern Asia and North America has new canes and inflorescences densely covered with slender spines, stipitate glands, and soft

white hairs. In 1846 C. A. Meyer described a prickly plant probably from the Altai region as *R. idaeus* var. *aculeatissimus*. But the name has hitherto been overlooked by subsequent botanists, and Focke in 1896 proposed the name subsp. *melanolasius* for the Eastern Asiatic and western American plant without indicating the type. A specimen from Ajan (Tiling) regarded as var. *aculeatissimus* has stems densely prickly with broad-based brown prickles and somewhat small leaves, and its young branches, petioles, pedicels and calyx-tubes are prickly and glandular-setose but very sparsely hairy or glabrescent, and it matches with some specimens from Saghalien and Yezo. But most of specimens from Saghalien, Kuriles and Yezo have young branches, petioles and pedicels more densely white-pubescent beneath the spines. *R. sachalinensis* Lév., of which I have examined the syntype specimens, has middle-sized leaflets with incised double serration, and stems densely or sparsely prickly with often slender acicular spines. *R. Matsumureanus* Lév. et Vnt. is a robust form common in Yezo having large broad leaflets with rather small teeth.

A form without stipitate glands occasionally found in Yezo and Saghalien, is named as var. *subinermis* (Koidz.) Koidz. (*R. karafutoanus* Koidz.); and var. *concolor* (Komar.) Nakai (*R. kanayamensis* Lév. et Vnt., *R. Komarovi* Nakai) having leaves not white-lanate beneath and hairy only on veins, occurs here and there in Yezo, Saghalien, Korea and Manchuria. Some specimens from northern Korea, Manchuria and Amur have dense dark-purplish prickles and glandular setae up to the calyx.

As the degrees of pubescence and the thickness and colour of prickles are not stable, I regard all the forms above mentioned as a single geographical race under the earliest subspecific name, subsp. *melanolasius* Focke.<sup>18)</sup>

Compared with these northern ones, the plant on mountains of Honshu having slender glabrescent branches with scattered spines, smaller narrower leaflets, white-pubescent inflorescences with a few small prickles but without glandular hairs, slender pedicels, smaller flowers, and long caudate tips of calyces, i.e. subsp. *nipponicus* Focke, looks very different. An extreme form with quite glabrous pedicels and calyx-tubes, var. *Yabei* (Lév. et Vnt.) Koidzumi, is sometimes found too; and var. *marmoratus* (Lév. et Vnt.) Hara<sup>19)</sup> with leaves not white lanate beneath and hairy only on nerves is not uncommon in central Honshu.

18) *Rubus idaeus* L. subsp. *melanolasius* Focke in Abh. Nat. Ver. Bremen 13: 472 & 473 (1896), ut Unterarten. — *R. idaeus* var. *aculeatissimus* C. A. Meyer, Ind. Sem. Hort. Petrop. 11 Suppl.: 61 (1846). *R. idaeus* var. *aculeatissimus* Regel et Tiling, Fl. Ajan. 87 (1858). *R. idaeus* subsp. *sachalinensis* (Lév.) Focke in Bibl. Bot. 17: 210 (1911).

subsp. *nipponicus* Focke in Abh. Nat. Ver. Bremen 13: 471 & 473 (1896).

var. *marmoratus* (Lév. et Vnt.) Hara, comb. nov. — *R. marmoratus* Lév. et Vnt. in Bull. Soc. Agr. Sci. Art. Sarthe 60: 65 (1905). *R. yatsugatakensis* Koidzumi in Bot. Mag. Tokyo 23: 176 (1909). *R. Yabei* var. *marmoratus* (Lév. et Vnt.) Ohwi in Bull. Sci. Mus. Tokyo 26: 10 (1949).



Subsp. *nipponicus*, however, gradually merges into subsp. *melanolasius* through var. *hondoensis* Koidz. in Honshu, connected with numerous intermediate forms. Var. *hondoensis* of Honshu resembles subsp. *nipponicus* in its general appearance, but its branches and its inflorescences are densely covered with slender spines and stipitate glands as in subsp. *melanolasius*, and the similar form is also found on mountains of Yezo and Saghalien.

A common race in North America, i.e. subsp. *strigosus* (Michx.) Focke, has often glabrous new canes and branches, but the specimens referred to var. *canadensis* Richardson having white-pubescent new canes and branches are hardly separable from the Japanese plants, as Fernald and Koidzumi have pointed out, and they agree most closely with var. *hondoensis*.

Lit. Focke, Spec. Rubor. 2 in Bibl. Bot. 17 (Ht. 72): 207 (1911); Fernald in Rhodora 21: 89 (1919); Koidzumi, Fl. Symb. Or.-Asia 55 (1930); Rehder in Journ. Arnold Arb. 18: 51 (1937); Bailey in Gent. Herb. 5-10: 859 (1945); Hultén, Fl. Alaska 6: 1000 (1946).

<b>Rubus pedatus</b> J. E. Smith	—————	<i>R. pedatus</i>
Saghal., Yezo, n. & c. Honshu		[s. Alaska, Yukon, Alberta, south
(mts.)]		to n. Calif. (mts.) & n. Idaho

<b>Rubus vernus</b> Focke	.....	<b>R. spectabilis</b> Pursh
( <i>R. spectabilis</i> subsp. <i>vernus</i> Focke)		e. Aleutian, Alaska, south to
w. Yezo (mts., rare), n. & c. Honshu		n. Calif., east to n. Idaho
(high mts.)		(2n=14)

*R. spectabilis* of western North America has softly pubescent calyces, elliptic petals, receptacle long-hirsute around scars of achenes, and coarsely reticulate achenes. The Japanese plant differs from it in having less pubescent calyces with sparse soft hairs, glandular-setose peduncles, broad obovate petals, glabrous receptacle, and coarsely foveolate achenes, and also tends to have broader leaflets and less sericeous bud-scales.

<b>Sanguisorba officinalis</b> L.	—————	<i>S. officinalis</i>	—————	<i>S. officinalis</i>
Europe, Caucasus, Asia Minor, C. Asia, Persia, Siberia (east to				Alaska & Yukon
Amur, Ochotsk, Kamt.), Mongolia, China				
var. <b>carnea</b> (Fisch.) Regel ex Maxim.				<b>S. microcephala</b> Presl
e. Siberia, Manch., China, Korea, Yezo,				Alaska to n. California
Honshu, Shikoku, Kyushu (2n=28)				

The Japanese plants, compared with the European ones, have generally more robust and branched stems with numerous spikes, elongate leaflets, more slender spikes, and less fimbriate stigmas, as pointed out by Nakai, and they belong to a slightly different race from the European, but seem to pass gradually into the typical form in continental Eastern Asia. I refer the Japanese race with great hesitation to var. *carnea*, as the latter may be a different one.

The plants growing in marshy places have longer cylindric spikes which are sometimes nodding than those growing in drier habitats. Some of them

were considered by Hultén as the hybrid between *S. officinalis* and *S. tenuifolia* Fischer, but in Japan they are common where the latter species is absent.

Lit. Hultén, Fl. Kamt. 3: 83 (1929); Nakai in Journ. Jap. Bot. 13: 476 (1937); Kitagawa, Lineam. Fl. Mansh. 274 (1939); Juzepczuk in Fl. URSS. 10: 422. (1941).

**Sanguisorba stipulata** Rafin. ——— *S. stipulata*

Ussuri, n. Korea, Saghal., c. & s. Kuril.,	( <i>S. sitchensis</i> C. A. Meyer)
n. & c. Yezo (alp.), n. & c. Honshu	[e. Aleut., Alaska, south to
(alp., isol.)]	Oregon & Idaho

In Japan this species is variable in the length of bracteoles and the hairiness of calyces. The typical form has short bracteoles and glabrous calyces, while var. *riishirensis* (Makino) Hara has long exserted bracteoles and pubescent calyx-tubes. Intermediate forms, however, are sometimes found, and specimens from Oregon have hairy calyx-tubes, and those from Sitcha have calyx-tubes only hairy at the apex. The specimens from eastern North America which have been referred to this species belong to *S. canadensis* L.

Lit. Hara in Journ. Jap. Bot. 10: 232 (1934), 23: 30 (1949).

**Sibbaldia procumbens** L. ——— *S. procumbens* ——— *S. procumbens*

n. & c. (mts.) Europe	[Chukch, Kamt., Saghal., Aleut.,	Alaska, British Columbia,
(2n=14) (east to Urals),	n. Kuril.] [c. Honshu (alp.)	w. Alberta, south to Calif.
w. Siberia (Obi bay)]	? <i>S. macrophylla</i> Turcz.	& Colorado; Mackenzie
	s. Siberia (Altai, Dahuria, Ussuri?),	to s. Baffin, Labrador,
	C. Asia, Himalaya?, Mongolia	south to New Hampshire
		(mts.); Greenland

Lit. Muravjova in Acta Inst. Bot. Acad. Sci. URSS. ser. 1, 2: 224 (1936); Juzepczuk in Fl. URSS. 10: 224 (1941).

**Spiraea betulifolia** Pallas ..... *S. lucida* Douglas

e. Siberia (Lena to Kamt., south to	British Columbia to Saskat-
Amur, Ussuri), Saghal., Kuril., Yezo, n.	chewan, south to Oregon,
Honshu (mts.)	Wyoming & S. Dakota
subsp. <i>Aemiliana</i> (Schneid.) Hara	———— <i>S. betulifolia</i>
e. Siberia (Amur, Ussuri, Ochotsk,	subsp. <i>Aemiliana</i>
Kamt., Chukch), Saghal., Kuril., Yezo	Alaska to Mackenzie
(alp.)	

The plant is extremely variable in the size and shape of leaves, and the degree of hairiness. As I have already pointed out in 1935, some Japanese specimens as well as those from Saghalien and Ussuri agree well with the plant illustrated by Pallas as *S. betulifolia*, and I do not doubt the identity of the plant.

The Japanese plant is usually glabrous in all parts, but a pubescent form is known from Ochotsk, and an intermediate form with glabrous inflorescences and very minutely pubescent young branches, i. e. var. *sachalinensis* Hara, is found in Saghalien and Amur.

On high mountains of Yezo, there occurs subsp. *Aemiliana*<sup>19)</sup> which has usually pubescent young branches, leaves, inflorescences and follicles, and which is distinguished from a dwarf alpine form of *S. betulifolia* also by having smaller more roundish leaves with finely impressed veins and veinlets. This race is distributed widely from northern East Asia to north-western North America, and an epithet *Aemiliana* should be used for it, as Koidzumi adopted the epithet in 1909 when he first united Schneider's *Aemiliana* and *Beauverdiana* which were published simultaneously.

The typical *S. betulifolia* closely resembles *S. lucida* of North America, as suggested by Hultén, but the latter tends to have sharply serrated lustrous leaves with longer petioles, and follicles generally with erect sepals. The both species, however, are not distinguishable by the shape of follicles and styles, and erect sepals are not a constant character of the American plant. For example, a specimen from Scurvy Mt. of Idaho (Kirkwood no. 1943) has reflexed sepals. The American plant may better be regarded as a geographical subspecies of *S. betulifolia*.

Lit. Schneider in Bull. Herb. Boiss. ser. 2, 5: 347 (1905); Hultén, Fl. Kamt. 3: 38 (1929); Hara in Bot. Mag. Tokyo 49: 117 (1935), in Journ. Jap. Bot. 13: 555 (1937); Pojarkova in Fl. URSS. 9: 288 (1939).

***Spiraea chamaedryfolia* L. — *S. chamaedryfolia***

(*S. ulmifolia* Scopoli)

s. e. Europe, C. Asia, s. Siberia (Altai to Dahuria), Mongolia

( $2n=36$ )

var. ***pilosa*** (Nakai) Hara<sup>20)</sup>

(*S. ussuriensis* Pojark.)

Amur, Ussuri, Manch., Korea, s. Yezo,

n. & c. Honshu (mts.)

***S. flexuosa*** Fisch. ex Cambess.

s. Siberia (Altai to Ussuri), n. Mon-

gol., Manch., n. Korea ( $2n=18$ )

The Japanese plant is more hairy than the typical *S. ulmifolia* of Austria which has leaves glabrous above and hirsute mostly on nerves beneath, glabrous inflorescences and calyces, slightly larger flowers, and follicles hairy only along the inner suture.

19) *Spiraea betulifolia* Pallas, Fl. Ross. 1: 33, t. 16 (1784).

subsp. ***Aemiliana*** (Schneid.) Hara, stat. nov. — *S. Aemiliana* Schneider in Bull. Herb. Boiss. ser. 2, 5: 347 (1905); Ill. Handb. Laubh. 1: 477 (1905). *S. Beauverdiana* Schneider, Ill. cc. 348 & 478 (1905). *S. Steveni* (Schneid.) Rydberg in N. Amer. Fl. 22-3: 247 (1908). *S. betulaefolia* var. *Aemiliana* (Schneid.) Koidzumi in Bot. Mag. Tokyo 23: 166 (1909).

var. ***glabra*** (Hara) Hara, comb. nov. — *S. Aemiliana* var. *glabra* Hara in Bot. Mag. Tokyo 49: 117 in adnota (1935).



An extreme form found on mountains of Japan has pubescent young branches, leaves, inflorescences, calyces and follicles, and I name it here as var. *pubescens* Hara.<sup>20)</sup>

In Japan, however, the degrees of hairiness are variable, and specimens with glabrous inflorescences and calyces are common too, but they have often follicles appressed hairy on the back at least in the upper part.

The plant of Korea and Manchuria is less hairy than the Japanese, and its inflorescences and calyces are glabrous and its follicles are pubescent generally on the ventral side only. The type specimen of var. *pilosa* (Nakai)<sup>20)</sup> has hairy leaves, inflorescences and calyces, but has follicles densely ciliate only along the inner suture and glabrous on the back, and the same form is rarely found in central Honshu.

Besides the hairiness, the plant is variable in the shape and serration of leaves, the shape of calyx-lobes and the size of flowers, and some Japanese specimens well match with the European ones in the shape of leaves.

As I could find no essential characters to separate the Eastern Asiatic plant specifically from *S. ulmifolia*, I regard it as a race of the latter. The application of Linnean *S. chamaedryfolia*<sup>21)</sup> is very confusing, but I follow the interpretation of Jacquin who first defined it based on the identification of Linnaeus himself.

Lit. Pojarkova in Fl. URSS. 9: 291 (1939).

**Spiraea media** Schmidt ————— *S. media*

e. Europe (Austria and C. Asia, Siberia (east to Ussuri, Ochotsk, eastwards) (2n=18) Kamt.), Mongolia

var. *sericea* (Turcz.) Regel  
ex Maxim.

s. e. Siberia (Dahuria to Ussuri), Mongol., Manch., Yezo?

var. *monbetsusensis* (Fr.)

Cardot ex Nakai

Manch., n. Korea, Saghal., s. Kuril., Yezo

Lit. Nakai in Bot. Mag. Tokyo 42: 464 (1928); Pojarkova in Fl. URSS. 9: 294 (1939).

20) *Spiraea chamaedryfolia* L., Sp. Pl. ed. 1, 489 (1753), emend. Jacquin, Hort. Vindob. 2: 66, t. 140 (1772).

*S. ulmifolia* Scopoli, Fl. Carn. ed. 2, 1: 349, t. 22 (1772).

var. *pilosa* (Nakai) Hara, comb. nov. — *S. ulmifolia* var. *pilosa* Nakai in Bot. Mag. Tokyo 42: 467 (1928).

var. *pubescens* Hara, var. nov. — Rami juveniles, folia utrinque, inflorescentiae calycesque pubescentes. Follicli etiam dorso adpresse pubescentes.

Typus. Honshu. Prov. Iwashiro: Higashiyama, Aizu (G. Koidzumi, Mai 1910, in Herb. Univ. Tokyo).

- Spiraea salicifolia** L. ————— *S. salicifolia* ..... **S. Menziesii** Hooker  
 c. Europe (2n=36), Siberia (Obi, east to Ussuri, Kamt., s. Alaska to Oregon, east  
 (Bohemia & Austria Chukch), n. Mongol., n. China, Manch., to Idaho  
 to Polonia) Korea, Saghal., Kuril., Yezo, n. & c. **S. alba** Du Roi (2n=36) &  
 Honshu (mts.) **S. latifolia** (Ait.) Borkh.  
 (2n=36); eastern N. America

The leaves of Japanese plants are generally lanceolate or oblong-lanceolate and acute at the apex, but sometimes become elliptic and obtuse. A form having elliptic leaves, and velutinous-tomentose new branches, inflorescences and calyces, is rarely found in Saghalien, and it is referable to var. *humilis* (Pojark.) Hara.<sup>21)</sup>

- Astragalus frigidus** ————— *A. frigidus* ..... **A. americanus** (Hook.)  
 (L.) A. Gray Siberia, w. Himalaya, n. Mongolia M. E. Jones  
 n. & c. (mts.) Europe subsp. **parviflorus** (Turcz.) Hultén Alaska, Mackenzie, to  
 (2n=16) (*A. secundus* auct.) Ontario, south to n.  
 Dahuria, Yakutsk, Ochotsk, Ussuri, Kamt., Wyoming & S Dakota  
 n. Kuril., Yezo (Rishiri, Daisetsu Mts.) [c. var. **gaspensis**  
 Honshu (alp.) (Rousseau) Hultén  
 Quebec

Lit. Hultén, Fl. Kamt. 3: 98 (1929), Fl. Alaska 7: 1085 & 1090 (1947); Fernald in Rhodora 39: 313 (1937).

- Hedysarum hedysaroides** ————— *H. hedysaroides*  
 (L.) Schinz et Thell. (*H. obscurum* L.)  
 Europe, Asia Minor, Caucasus, Himalaya, Siberia (east to Ussuri,  
 Kamt., Chukch), Saghal., Kuril., n. Korea,  
 Yezo (alp.)

The plant is variable in the hairiness of inflorescences, leaves and ovaries, the shape of leaflets, and the length of calyx-lobes. Both forms with glabrous or appressed pilose ovaries and legumes occur in Yezo, Kuriles and Saghalien. The marginal wings of legumes are often very narrow. Many closely allied species have been described from Siberia and China. *H. Iwawogi* Hara of Honshu and central Yezo has always yellowish flowers and less hairy calyces with short triangular lobes.

Lit. Fedtschenko in Acta Hort. Petrop. 19: 231 (1902); Hand.-Mzt., Symb. Sin. 7-3: 559 (1933); Hara in Bot. Mag. Tokyo 49: 793 (1935), 52: 624 (1938).

- Lathyrus maritimus** ————— *L. maritimus* ————— **L. maritimus**  
 (L.) Bigelow (*L. japonicus* Willd.) Aleut., Alaska to Calif.;  
 Europe (south to n. France & n. Spain) (2n=14), arctic Lake Winnipeg, Great Lakes;  
 Siberia (along coasts east to Chukch, Labrador south to Delaware  
 then to Kamt., Ochotsk, Ussuri, n. (2n=14); s. Greenland  
 China, s. Manch., Korea, Saghal., Kuril.,  
 Yezo south to Kyushu (2n=14)

21) *Spiraea salicifolia* var. **humilis** (Pojark.) Hara, stat. nov.—*S. humilis* Pojarkova in Fl. URSS. 9: 287 & 489 (1939).

A pubescent race, var. *aleuticus* Greene, occurs from Yezo northwards, mixed with a glabrous race.

Lit. Fernald in *Rhodora* 34: 177 (1932); C. Regel in Fedde, Rep. 38: 56 (1935); Hara in Bot. Mag. Tokyo 49: 793 (1935); Fassett, Legumin. Pl. Wisconsin 117, maps (1939).

<b>Lathyrus palustris</b> L. ————— <i>L. palustris</i> ————— <i>L. palustris</i>	
Europe, Caucasus, w. Siberia (east to Yenisei, Irkutsk),	British Columbia to Newfld.,
(2n=42) China	south to n. Calif., Colorado,
	Minnesota & N. Carolina
	(2n=14)
subsp. <b>pilosus</b> (Cham.) Hultén ————— subsp. <i>pilosus</i>	
Siberia (east to Amur, Ussuri, Kamt.),	Aleut., Alaska to Oregon;
Manch., Korea, Saghal., Kuril., Yezo,	Minnesota to n. Labrador,
n. & c. Honshu	south to Connecticut

As I have reported in 1943, all Japanese plants belong to subsp. *pilosus*. They are variable in the shape of leaflets as in the typical *L. palustris*, but var. *macranthus* (White) Fernald with leaflets 5–10 mm wide prevails in Japan. The typical slender subsp. *pilosus* with narrow leaflets is sometimes found in the northern districts, while a robust form with broad stipules and elliptic roundish leaflets attaining 5 cm long and 2 cm wide is scattered here and there.

Lit. Fernald in *Rhodora* 13: 47 (1911); Hultén, Fl. Kamt. 3: 115 (1929), Fl. Aleut. 236 (1937), Fl. Alaska 7: 1117 (1947); Fassett, Legumin. Pl. Wisconsin 120, maps (1936); Hara in Journ. Jap. Bot. 19: 296 (1943).

<b>Lotus corniculatus</b> L. ————— <i>L. corniculatus</i>	
Europe (2n=24), Caucasus, Africa	Siberia, Persia, Himalaya, China
subsp. <b>tenuifolius</b> (L.) Reichb.	var. <b>japonicus</b> Regel
Europe (2n=12), western Asia,	Korea, Yezo, Honshu (2n=12),
n. Africa	Shikoku, Kyushu, Ryukyu, For-
	mosa

Lit. Nakai in Bot. Mag. Tokyo 45: 119 (1931).

<b>Trifolium Lupinaster</b> L. ————— <i>T. Lupinaster</i> ————— <i>T. Lupinaster</i>	
e. Europe (west to Prussia), C. Asia, Siberia (east to Jakutsk, Amur,	c. Alaska (wild?)
Ussuri) (2n=48), n. Mongolia, n. China, Manch.,	
Korea, Saghal., Kuril., Yezo, n. & c. Honshu	

The leaves of the Japanese plants are on the average broader than those of the Siberian ones, and they are oblong to lanceolate, 1.5–3.5 (4) cm long 5–11 mm wide, and acute or obtuse at the apex. This race is referable to var. *oblongifolium* Seringe (subvar. *obtusifolium* Belli, *T. pacificum* Bobrov).

Lit. Vierhapper in Oester. Bot. Zeits. 67: 257 (1918); Bobrov in Jubil. Spornik Komarov 140 (1939), in Fl. URSS. 11: 200 (1945).



Europe (2n=28),  
n. Africa  
Caucasus, Siberia (east to Ussuri, Kamt.)  
(2n=12, 14, 28), C. Asia, China, Manch.,  
Korea, Saghal., Kuril., Yezo, Honshu, Shikoku,  
Kyushu, Formosa (2n=12)

Lit. Hara in Bot. Mag. Tokyo 49: 797 (1935).

Europe (2n=22), Siberia (east to Ussuri, Kamt.), Himalaya, (O. montana Rafin.) Caucasus, Mongolia, China, Manch., Korea, Saghal., [Manitoba to s. Newfld., n. Africa Kuril., Yezo, Honshu, Shikoku, Kyushu (mts.)] south to Minnesota, Tennessee & N. Carolina (mts.)  
subsp. **japonica** (Fr. et Sav.) Hara  
Honshu, Shikoku, Kyushu (2n=22)

The Japanese plant common in cool coniferous woods on higher mountains agrees well with *O. Acetosella* of Europe. The specific distinction between the European and American plants pointed out by Fernald, seems to me to be untenable, and some Japanese specimens have oblong emerginate petals, distinctly ciliate sepals, and depressed capsules as in the American plants. They all have slender rhizomes and broad obcordate leaflets with round lobes.

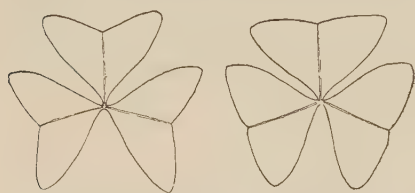


Fig. 5. *Oxalis Acetosella*  
subsp. *japonica*. Leaves  $\times 2/3$ .

A robust form, var. *vegeta* Tatewaki, with the same shape of leaflets as that of *O. Acetosella*, is found in the Japan Sea region of Honshu and Yezo. It has thicker rhizomes, larger leaflets attaining 3-5 cm wide, and larger flowers with broad petals. The material of Mt. Hakoda, on which the report of chromosome-number  $2n=35$  was based, may

probably belong to this variety derived from *O. Acetosella*.

Another race, subsp. *japonica*,<sup>22)</sup> is growing at lower altitudes in middle and western Japan. It is more robust and hairy than the typical *O. Acetosella*, and has thicker rhizomes more thickly covered with longer persistent bases of old petioles, more obtriangular larger leaflets with more divaricate lobes obtuse (not round) at the top (Fig. 5), and longer capsules with larger seeds. The race is generally easily separable from *O. Acetosella* in the shape of leaflets, but puzzling intermediate forms are sometimes found in Honshu. Colonies with rose-purplish flowers are occasionally found both in *O. Acetosella* and subsp. *japonica*.

The plant of Formosa is a slightly different form having slender rhizomes and depressed obtriangular leaflets with a broad deep sinus and obtuse lobes.

Lit. Fernald in *Rhodora* 20: 76 (1918); Knuth in *Engl. Pfl.-reich* IV-130, Ht. 95: 231 (1930).

<i>Oxalis fontana</i>	<i>O. fontana</i> Bunge	<i>O. fontana</i>
( <i>O. stricta</i> L. p. p., <i>O. europaea</i> Jordan)	Ussuri, China, Manch., Korea, Yezo, Honshu, Kyushu]	[N. Dakota to Ontario, Quebec, south to Arizona & Florida; with several varieties and forms.
(Europe, intr., $2n=24$ )		

The variation in this species was discussed in my paper of 1949. I avoid to use the confusing name, *O. stricta* L., which has been applied to two different species in Europe and in North America for these fifty years.

Lit. Wiegand in *Rhodora* 27: 113 & 134 (1925); Knuth in *Engl. Pfl.-reich* IV-130, Ht. 95: 142 & 434 (1930); Hara in *Journ. Jap. Bot.* 24: 101 (1949).

22) *Oxalis Acetosella* L. subsp. *japonica* (Franch. et Sav.) Hara, stat. nov. — *O. japonica* Franch. et Sav., *Enum. Pl. Jap.* 2: 308 (1877). *O. Acetosella* var. *japonica* (Fr. et Sav.) Makino in *Bot. Mag. Tokyo* 22: 171 (1908).

**Euphorbia Esula** L. ————— **E. Esula**

Europe, Asia Minor, Siberia, Mongol., China

**E. Nakaiana** Lév.

(E. Nakaii Hurusawa)

Korea, c. Honshu (Tokai distr., isol.)

Closely allied species *E. uralensis* Fischer ex Link and *E. Maackii* Meinsh. are also known from Eastern Asia.

Lit. Hurusawa in Journ. Jap. Bot. 16 : 450 (1940); Croizat in Journ. Jap. Bot. 17 : 576 (1941).

**Euphorbia Helioscopia** L. ————— **E. Helioscopia**

Europe (2n=12, 18, ca. 32, 42), C. Asia, s. Siberia, India, China,  
n. Africa Manch., Korea, Honshu, south to Formosa

**Callitriche verna** L. ————— **C. verna** ————— **C. verna**

emend. Kützing	( <i>C. fallax</i> & <i>C. elegans</i> Petrov)	e. Aleut., Alaska to La-
( <i>C. palustris</i> L., p. p.)	Siberia (east to Ussuri, Ochotsk, Kamt.),	brador, south to n. Mexico,
Europe (2n=20)	China, Manch., Korea, Saghal., Kuril,	n. Ill., W. Virginia &
	Yezo, Honshu, Shikoku, Kyushu, Formosa	Maryland; Greenland

The Japanese plant has obovate fruits very narrowly winged above and styles (1) 1.5-2 mm long, and is a common weed in rice-fields. It is difficult to separate the Eastern Asiatic plants specifically from the European, although Petrov described several new species from Eastern Asia.

Lit. Petrov in Bull. Jard. Bot. Pric URSS. 27 : 360 (1928); Hara in Bot. Mag. Tokyo 49 : 866 (1935); Fassett in Rhodora 53 : 166 (1951).

**Rhus ambigua** Lavallée ..... **R. radicans** L.

(*R. orientalis* (Greene) Schneid.) s. British Columbia to Quebec,  
Saghal., Kuril., Yezo, Honshu, Shikoku, south to Mexico, Florida &  
Kyushu (south to Is. Yakushima), Bahama; with var. *Rydbergii*  
Formosa, c. & w. China (Small) Rehder, very variable  
in N. America.

Lit. Hara in Bot. Mag. Tokyo 49 : 866 (1935), in Journ. Jap. Bot. 15 : 454 (1939).

**Ilex macropoda** Miq. .... **I. montana** Torr. & Gray

China, Korea, Yezo, Honshu, Shikoku, New York, south to Alabama  
Kyushu & Georgia (mts.)

Lit. Hara in Bot. Mag. Tokyo 50 : 187 (1936); Fernald in Rhodora 41 : 428 (1939); Hu in Journ. Arnold Arb. 30 : 279 (1949).

**Acer pycnanthum** K. Koch ..... **A. rubrum** L.

( <i>A. rubrum</i> var. <i>pycnanthum</i>	[Manitoba to Newfld., south
(Koch) Makino)	to Texas & Florida (2n=78,
c. Honshu (Omi, Mino, s. Shinano	104)
& Mikawa)]	



**Impatiens noli-tangere** L. — *I. noli-tangere* ————— *I. noli-tangere*  
 Europe (2n=20), Caucasus, Asia Minor, Siberia, (east to ( *I. occidentalis* Rydb.)  
 Ussuri, Kamt.), China, Manch., Alaska to Lake Athabaska,  
 Korea, Saghal., Kuril., Yezo, Honshu, south to Washington  
 Shikoku, Kyushu

**Triadenum japonicum** (Bl.) ..... **T. virginicum** (L.) Rafin.  
 Makino (*Hypericum virginicum* L.)  
 Amur, Ussuri, Manch., Korea, Manitoba to s. Labrador, south to  
 Yezo, Honshu, Shikoku, Kyu- Minn., Nebraska, Indiana & Florida  
 shu; with several forms (2n=38); with var. *Fraseri* (Spach)  
 & also *T. tubulosum* (Walter)  
 Gleason.

The Eastern Asiatic plant differs clearly from the typical form of *T. virginicum*, but the eastern North American plants are highly variable in the shape of leaves, the size and shape of sepals, the shape of capsules, the length of styles, and the length of the connate part of stamens, and the careful comparison of plants in both regions is needed.

Lit. Y. Kimura in Journ. Jap. Bot. 11: 837 (1935), in Nova Fl. Jap. 10: 79 (1951); Fernald in Rhodora 38: 433 (1936).

**Elatine triandra** Schkuhr ————— *E. triandra* ————— *E. triandra*  
 Europe (2n=ca. 40), s. Siberia (Tomsk), Manch., Kamt., Colorado, S. Dakota, Wisconsin  
 n. Africa China, Korea, Honshu, Shi- & Maine (intr.?)  
 koku, Kyushu, Formosa?, var. *andina* Fassett  
 India, Tonkin, Java S. America  
**E. americana** (Pursh) Arn.  
 British Columbia to New  
 Brunsw., south to Calif., Texas  
 & N. Carolina

The plant found in rice-fields of Japan has often flowers with short pedicels 0.3-1.5 mm long and has been referred to var. *orientalis* Makino (*E. orientalis* Makino), but some Japanese specimens have subsessile flowers as in the typical *E. triandra*. Var. *orientalis* seems to be the same as var. *pedicellata* Krylov (*E. ambigua* Wight) reported from India, China (Yunnan), Java, Siberia (Tomsk, Amur?) and also rarely from Europe (Ukraine, Hungary). The Asiatic materials of the genus, particularly from Formosa, Kamtchatka, and Hainan should be studied critically and compared carefully also with *E. gratioloides* Cunn. from Australasia and Fiji and with *E. oryzetorum* Komarov of Ussuri and Manchuria.

Lit. Fernald in Rhodora 19: 10 (1917), 43: 208 (1941); Fassett in Rhodora 41: 368 (1939); Gauthier & Raymond in Contr. Inst. Bot. Univ. Montréal 64: 30 (1949).

**Viola biflora** L. ————— *V. biflora* ————— *V. biflora*  
 n. & c. (mts.) Europe, Caucasus, Siberia (east to Ochotsk, s. Ussuri, Alaska, Yukon)  
 (2n=12) Kamt., Chukch), C. Asia, Himalaya, Mongol., [Colorado  
 n. & w. China, Manch., n. Korea, Saghal.,

Kuril., Yezo, Honshu, Shikoku (alp.), Kyushu  
(Is. Yakushima) ( $2n=12$ )

**V. crassa** Makino

Korea, Saghal., Kamt., Kuril., Yezo, n. & c.  
Honshu (alp.)

Lit. Becker in Beih. Bot. Centralbl. Abt. 2, 36: 39 (1918).

**Viola blandaeformis** Nakai ..... **V. blanda** Willd.

Yezo, n. & c. Honshu (mts.)	[Minnesota to Quebec, south to
var. <b>pilosa</b> Hara	Illinois, Georgia (mts.) & Mary-
(? <i>V. Hultenii</i> W. Becker)	land
Kamt., Kuril., Saghal., e. Yezo,	var. <b>Macloskeyi</b> (Lloyd) Jepson
c. Honshu]	[British Columbia to Calif. &
	Colorado

The plant of Honshu which is similar to *V. blanda* of North America and has subreniform leaves glabrous on both sides, was described by Nakai in 1925 as *V. blandaeformis*. Becker in 1928 separated from *V. blanda* the Eastern Asiatic plants including the Japanese one as *V. Hultenii*, but he based his description on the plant of Kamtchatka which has thinner rhizomes, smaller stipules, smaller flowers and smaller leaves sparsely hairy above, compared with *V. blandaeformis*. A form with leaves sparsely hairy above is found in Kuriles and eastern Yezo, and very rarely in central Honshu<sup>23)</sup>. It is certain that the Eastern Asiatic plants are somewhat different from the western American ones, but *V. Hultenii* seems to be a northern form of *V. blandaeformis*.

Lit. Brainerd, Viol. N. Amer. 81 (1921); Nakai in Bot. Mag. Tokyo 36: (58) (1922), in Bull. Soc. Bot. France 72: 192 (1925); Becker et Hultén in Ark. f. Bot. 22 A-3: 4 (1928); Miyabe et Tatewaki in Trans. Sapporo Nat. Hist. Soc. 13: 381 (1934).

**Viola mirabilis** L. ————— *V. mirabilis*

Europe ( $2n=20$ ), Caucasus, Siberia (east to Yenisei)

var. **subglabra** Ledeb.

Siberia (Tobolsk to Amur, Ussuri),  
Manch., Korea, Yezo?, Honshu ( $2n=20$ )

The Japanese plant has glabrous stems and petioles.

Lit. Becker in Fedt., Fl. Aziat. Russ. 8: 28 (1915), in Beih. Bot. Centralbl. Abt. 2, 40: 20 (1923); Kitagawa in Bot. Mag. Tokyo 48: 103 (1934).

**Viola rostrata** Pursh ————— *V. rostrata*

Yezo, n. & c. Honshu]	[Wisconsin to Quebec, south to Ala-
(the Japan Sea side)	bama (mts.) & New Jersey ( $2n=20$ )

23) *Viola blandaeformis* Nakai var. **pilosa** Hara, var. nov.—A typo foliis supra parce strigoso-pilosis, floribus minoribus differt. Petala alba, inferiora violaceo-venosa.

Typus. Honshu. Prov. Iwashiro: Oze (T. Kawasaki, Jun. 12, 1948 in Herb. Univ. Tokyo).





The glabrous plants common on high mountains of Japan agree well with the European ones, although they look very different when growing in different habitats. Var. *pilosula* with stems and the upper surface of leaves minutely pubescent, and glabrescent inflorescences, is local in central Honshu and Yezo, but it is a prevailing race in Manchuria and Korea where it often becomes robust attaining 20–30 cm high. Another pubescent race, var. *imaicola*, is characterized by having leaves roundish or broad cuneate at the base, and minutely glandular-pubescent inflorescences, and it occurs in the more southern districts.

Lit. Hand.-Mzt., Symb. Sin. 7-3: 602 (1933); Hara in Journ. Jap. Bot. 10: 588 (1934), 20: 326 (1944).

***Circaea quadrisulcata*** - - - - - *C. quadrisulcata*

Franch. et Sav.	var. <b>canadensis</b> (L.) Hara
s. Siberia (Altai to Amur, Ussuri)]	[North Dakota to Nova Scotia,
n. China, Manch., Korea, Saghal.,	south to Oklahoma, Tenn. &
Yezo, c. Honshu	Georgia

The eastern North American plant differs slightly from the Eastern Asiatic one in having minute setaceous bracteoles, generally green glabrescent sepals, and white petals.

Lit. Fernald in Rhodora 19: 85 (1917); Hara in Journ. Jap. Bot. 10: 598 (1934), in Rhodora 41: 386 (1939).

***Epilobium angustifolium* L.** — *E. angustifolium* ————— *E. angustifolium*

( <i>Chamaenerion angustifolium</i> (L.) Scopoli)	Alaska to c. Baffin, Labrador,
Europe (2n=36), Asia Minor, Caucasus, Siberia (east to	south to Calif., Texas & N.
Ussuri, Kamt., Chukch), Himalaya,	Carolina (mts.); Greenland
Mongol., China, Manch., Korea,	
Saghal., Kuril., Yezo, Honshu	

Lit. Fernald in Rhodora 20: 1 (1918); Hultén, Fl. Alaska 7: 1143 (1947).

***Epilobium glandulosum* Lehm.** ——— *E. glandulosum*

Amur, Ussuri, Kamt., Kuril.	Aleut., Alaska to Labrador, south to
var. <b>asiaticum</b> Hara	n. Calif., Colorado, Minnesota &
Kamt., Korea, Saghal., s.	New York
Kuril., Yezo, n. & c. Honshu	var. <b>adenocaulon</b> (Hausskn.) Fern.
(mts.)	Alaska to Newfld., south to Calif.,
	New Mexico & Pennsylv.; other
	varieties in N. America.

This species is very variable, and parallel variations are observed in Eastern Asia and North America.

Var. *kurilense* (Nakai) Hara of Kuriles and Kamtchatka is very near to the typical *E. glandulosum*, and has large leaves up to the crowded inflorescences, larger flowers 5–7 mm long, ovaries with curved hairs only, and seeds obtuse

at the top and 1.2–1.4 mm long, and a similar form is found in Ontario too.

While var. *asiaticum* Hara which is distributed from northern Honshu north to Korea, Saghalien and Kamtchatka, has leaves conspicuously decreasing in size into the more open often branched inflorescences, smaller flowers 3.5–5 mm long, ovaries densely covered with curved hairs often mixed with glandular ones, and seeds rounded at the top, strongly papillose and 0.8–1.2 mm long. It is the Asiatic race corresponding to var. *adenocaulon* of North America, and some specimens from Labrador and Newfoundland agree well with the Eastern Asiatic ones.

Intermediate forms between the two forms above mentioned occur sometimes in southern Kuriles and Saghalien, and some specimens from Is. Etorof have middle leaves attenuate at the base, and thus approach to var. *adenocaulon*.

Lit. Fernald in *Rhodora* 20: 31 (1918); Hara in *Journ. Jap. Bot.* 18: 238 (1942).

***Epilobium hirsutum* L. ————— *E. hirsutum***

Europe (2n=36 (54)), Asia Minor, Siberia, n. India, China, Manch.,  
n. Africa n. & c. Korea, Dagelet, c. Honshu (I.  
Sado, Iwashiro)

The very isolated localities of this species in Japan may be related to a passage of migratory water-fowls.

Lit. Haussknecht, *Monogr. Epilob.* 53 (1884); Hara in *Journ. Jap. Bot.* 18: 178 (1942).

***Epilobium Hornemanni* Reichb. — *E. Hornemanni* ————— *E. Hornemanni***

n. Europe (2n=36), n. Siberia?, Ochotsk, Kamt. Alaska to Labrador, south to  
var. *Foucaudianum* (Lév.) Hara Calif., Colorado & New Hamp-  
(*E. Foucaudianum* Lév.) shire (mts.); Greenland  
Saghal., Yezo, n. & c. Honshu (mts.)

The Japanese plants (var. *Foucaudianum*) have generally narrower leaves 8–40 cm long and 3–14 mm wide, smaller flowers with petals 3.5–4.5 mm long, shorter stigmas about half as long as the style, and papillose seeds. But some specimens on Mt. Daisetsu of Yezo agree well with those of northern Europe.

The closely allied *E. sertulatum* Hausskn., with thicker leaves and smooth seeds occurs in Kuriles, and this group needs further critical studies based on ample materials.

Lit. Hultén, *Fl. Kamt.* 3: 146 & 149 (1929), *Fl. Alaska* 7: 1149 (1947); Hara in *Journ. Jap. Bot.* 18: 242 & 247 (1942).

***Epilobium montanum* L. ————— *E. montanum***

Europe (2n=36), Caucasus, Asia Minor, Himalaya, Siberia (to Altai,  
Dahuria)) [Saghal., s. Kuril., Yezo, n. & c.  
Honshu

In the Japanese specimens, teeth on the margin of leaves are often less conspicuous than those of the European ones.

Lit. Hausskn., Monogr. Epilob. 74 (1884); Hara in Journ. Jap. Bot. 18: 179 (1942).

**Epilobium palustre** L. ——— *E. palustre* ——— *E. palustre*

Europe (2n=36), Caucasus, Asia Minor, Siberia (east to	Alaska to s. Labrador, south to
Ussuri, Kamt., Chukch), Himalaya,	Oregon, Colorado & Connecticut;
w. China, Manch., Korea, Saghal.,	Greenland; with several va-
Kuril., Yezo, n. & c. Honshu	rieties.

This polymorphic species is variable also in Japan especially in the shape of leaves. Some specimens from eastern Yezo and Kuriles which have linear-lanceolate leaves 2-5 mm wide with the slightly revolute margin, seem to be referable to var. *lavandulaefolium* Lecoq et Lamotte, but a form with lanceolate or broad lanceolate flat leaves 4-13 mm wide is more common in Japan and also in Saghalien, Korea and Manchuria. An extreme form, f. *asiaticum* Hara with lanceolate-ovate leaves rounded at the base and 6-15 mm wide, occurs in Kuriles, northern Honshu and Korea.

*E. fastigiatoramosum* Nakai (*E. palustre* var. *mandjuricum* Hausskn.) is rarely found in Yezo as well as in Korea, Manchuria, Ussuri and Amur, and it differs from *E. palustre* in having narrow-oblong seeds 1-1.5 mm long, smaller flowers 3.5-4.5 mm long, smaller calyces 2.5-3.5 mm long, narrow-oblong leaves tapering to both ends, and sometimes many ascending branches.

Lit. Hausskn., Monogr. Epilob. 128 (1884); Hara in Journ. Jap. Bot. 18: 180 (1942).

**Myriophyllum spicatum** L. — *M. spicatum* ——— *M. spicatum*

Europe (2n=36), Caucasus, Asia Minor, C. Asia, Siberia	Aleut., Alaska
Africa (east to Ussuri, Kamt.), India,	var. <i>exalbescens</i> (Fern.) Jepson
China, Manch., Korea, Saghal.,	(subsp. <i>exalbescens</i> Hult.,
Kuril., Yezo south to Formosa;	<i>M. exalbescens</i> Fern.)
Australia (intr.?)	Alaska to s. Labrador, south to
	Calif., Arizona, Kansas & Mary-
	land; Greenland; S. America
	(intr.?)

*F. muricatum* Neum. is often found in Japan from Yezo south to Formosa.

Lit. Fernald in Rhodora 21: 120 (1919); Hultén, Fl. Kamt. 3: 151 (1929), Fl. Alaska 7: 1159 (1947).

**Myriophyllum verticillatum** L. — *M. verticillatum* ——— *M. verticillatum*

Europe (2n=28), Asia Minor, C. Asia, Siberia, India,	Alaska, British Columbia to
n. Africa China, Manch., Korea, Yezo, Hon-	Newfld., south to c. Calif., Utah
shu, Shikoku	& Maryland

**Hippuris vulgaris** L. ——— *H. vulgaris* ——— *H. vulgaris*

Europe (2n=32),	Siberia (east to Ussuri, Ochotsk, Kamt.),	Alaska to Baffin, south
Caucasus	China, Manch., Saghal., Kuril., Yezo, n. &	to Calif., New Mexico,
	c. (mts.) Honshu	Minn. & Pennsylv.; Gre-
		enland; S. America



**Oplopanax japonicus** (Nakai) Nakai ... **O. horridus** (Smith) Miquel  
 e. Yezo, n. & c. Honshu (mts.)] [s. Alaska, south to Montana,  
**O. elatus** (Nakai) Nakai Calif., east to Manitoba,  
 s. Ussuri, Korea (mts.) Ontario & n. Michigan

In the Japanese plant, the leaf-lobes are deeply incised and unequally coarsely serrated, and long caudate-acuminate at the apex; the main nerves of leaves are prickly with thick spines; the calyx-lobes obsolete; the leaves sometimes peltate. But some specimens from northern Japan have shorter leaf-lobes and are only prickly with small spines on leaf-nerves.

The Korean plant has roundish leaf-lobes which are short-acuminate at the apex, not lobulate or with one lobule on each side, and closely and minutely serrated, and have no or small spines on nerves, and calyx-lobes often developed unequally.

Lit. Nakai in Journ. Arnold Arb. 5: 15 (1924), Fl. Sylv. Korea. 16: 37 (1927); A. C. Smith in N. Amer. Fl. 28 B: 11 (1944).

**Angelica genuflexa** Nutt. ————— **A. genuflexa**  
 (subsp. *refracta* (Fr. Schm.) Hiroe, Aleut., Alaska, along coasts  
*A. refracta* Fr. Schm.) south to n. Calif., Lesser Slave  
 Saghal., Kuril., Kamt., Yezo, n. & c. Lake distr.  
 Honshu

I could not find such differences between the North American and Japanese plants as pointed out by Hiroe. Compared with the type specimen of *A. refracta* from Saghalien, the North American plants have generally broader leaflets and slightly larger fruits 5 mm long, but some specimens agree well with the Japanese.

Lit. Hultén, Fl. Kamt. 3: 167 (1929); Hara in Bot. Mag. Tokyo 50: 366 (1936); Mathias & Constance in N. Amer. Fl. 28 B: 199 (1945); Hiroe in Act. Phytotax. & Geobot. 12: 175 (1950).

**Anthriscus sylvestris** (L.) Hoffm. — *A. sylvestris*  
 Europe (2n=16, 18), Caucasus, Asia Minor, Siberia (east to Ussuri,  
 Kamt.), C. Asia, Mongolia, China, Manch.,  
 Korea, Saghal., Kuril., Yezo south to Kyushu

The Eastern Asiatic plant has usually thin leaves with finely dissected and long-pointed distant pinnules, and a form in Europe with broader less dissected leaf-lobes is never seen in Eastern Asia. The distinction, however, is not clear, and the Eastern Asiatic plant should be considered as conspecific with a polymorphic *A. sylvestris*, although it may belong to a separate race. The degree of hairiness and the shape of involucral bracts are variable also in Eastern Asia, and fruits vary from smooth through scabrous to setose.

Lit. Thellung in Hegi, Ill. Fl. Mitt.-Europ. 5: 1017 (1926); Hultén, Fl. Kamt. 3: 154 (1929).

<b><i>Cicuta virosa</i> L.</b>	<b><i>C. virosa</i></b>	<b><i>C. maculata</i> L.</b>
n. & c. Europe (2n = 22 (44))	Siberia (east to Kolyma, Ussuri, Kamt.), Kashmir, n. Mongolia, n. China, Korea, Saghal., Kuril., Manch., Yezo, south to Kyushu (2n=22)	e. Manitoba to Quebec, south to Texas, Missouri & N. Carolina var. <b>Curtissi</b> (Coul. & Rose) Fernald Tenn. to New Jersey, south to n. e. Mexico, Texas & Florida

In Japan, the common form, var. *nipponica* (Franch.) Makino, has broad oblong-lanceolate leaf-lobes, but it is rare in Saghalien and Korea. A narrow-leaved form with lanceolate leaf-lobes which is the commonest form in Europe, is sometimes found in Yezo and Honshu, but is not uncommon in north-eastern Asia: Saghalien, Kuriles and Manchuria. A form corresponding to f. *angustifolia* (Kit.) Schube is also rarely met with on mountains of north and central Honshu.

The genus is especially polymorphic in North America. *C. mackenzieana* Raup with narrow linear leaf-lobes, and fruits similar to *C. virosa* in shape, occurs in Alaska and Canada east to Hudson Bay; *C. Douglasii* (DC.) Coulter & Rose in western North America from Alaska to California and New Mexico. Lit. Wolff in Engler, Pfl.-reich IV-228, Ht. 90: 77 (1927); Mathias & Constance in Madroño 6: 145 (1942), in N. Amer. Fl. 28 B: 154 (1944).

<b><i>Coelopleurum lucidum</i> (L.) Fernald</b>	- - - <b><i>C. lucidum</i></b>
var. <b>Gmelini</b> (DC.) Hara	( <i>C. cctaeifolium</i> Coul. & Rose)
( <i>C. Gmelini</i> (DC.) Ledeb.)	Aleut., Alaska to n. Calif., s. Siberia (Bering Straits, Kamt., Ochotsk, Ussuri), Saghal., Kuril., Yezo (along coasts and also on high mts.)
	s. Greenland

Mathias & Constance united the Eastern Asiatic plant (*C. Gmelini*) and the western American (*C. longipes*) with the eastern American one under the name *Angelica lucida* L. Although this species is polymorphous, the Eastern Asiatic plants seem to belong to a separate race from the eastern American.

Lit. Fernald in Rhodora 21: 144 (1919); Hultén, Fl. Kamt. 3: 166 (1929); Hara in Bot. Mag. Tokyo 50: 369 (1936); Mathias & Constance in N. Amer. Fl. 28 B: 194 (1945).

<b><i>Cryptotaenia japonica</i> Hasskarl</b>	..... <b><i>C. canadensis</i> (L.) DC.</b>
( <i>C. canadensis</i> var. <i>japonica</i> (Hassk.)	[Manitoba, S. Dakota to
Makino; subsp. <i>japonica</i> Hand.-Mzt.)	Quebec, south to Texas
China, Manch., Korea, Yezo, s. Kuril.,	& Georgia
Honshu south to Ryukyu (2n=20, 22)	

The Eastern Asiatic plant has nearly sessile leaflets, very narrow umbels with almost erect rays and pedicels, fewer (2-5)-flowered umbellules, 2-3 involucre bracts, and slightly shorter thick styles. It is commonly cultivated in Japan as a vegetable, and forms with lobed leaflets or dark-purple leaves are known.

The North American plant has distinctly petiolulated leaflets except the upper ones, often bifid lateral leaflets in the radical leaves, open umbels, 5-10-flowered umbellules, no or one involucre bract, and petals distinctly incurved at the apex.

Lit. Matsuda in Bot. Mag. Tokyo 26: (366) (1912); Hara in Bot. Mag. Tokyo 50: 370 (1936).

**Glehnia littoralis** Schmidt - - - - - *G. littoralis*

Ochotsk, Ussuri, Korea, s. Manch.,	subsp. <i>leiocarpa</i> (Math.) Hultén
China, Saghal., Kuriles, along	( <i>G. leiocarpa</i> Mathias)
coasts south to Ryukyu & For-	Alaska, along coasts south to
mosa (2n=22)	California

Lit. Mathias in Ann. Missouri Bot. Gard. 15: 93 (1928); Hara in Bot. Mag. Tokyo 50: 419 (1936); Hultén, Fl. Alaska 7: 1180 (1947).

**Heracleum lanatum** Michaux ————— *H. lanatum*

( <i>H. dulce</i> Fisch.)	Aleut., Alaska to s. Labrador,
Siberia?, Manch.?, Kamt., w. China?,	south to Calif., Missouri &
Saghal., Kuril., Yezo, Honshu (2n=22)	Georgia (mts.)

Recently Hiroe has separated the Eastern Asiatic plants from the American as subsp. *asiaticum* by the hairiness of leaves. The typical *H. lanatum* with leaves canescent-tomentose beneath, however, occurs in Yezo, Kuriles and Saghalien too. The plants on mountains of northern and central Honshu are generally glabrescent, and its leaves are often hairy only on larger nerves beneath. This glabrescent form<sup>25)</sup> accompanied by many intermediate ones is also found in Yezo, Kuriles and Kamtchatka, while the same parallel variations in the hairiness of leaves are observed in the American plant too. So it is impossible to distinguish the Asiatic plant from the American as a different geographical race by the hairiness.

It is remarkable that a race with pinnately 5-lobed radical and lower leaves which are never found in North American, occurs in central and western Honshu, Shikoku, Kyushu, Korea, Manchuria, and north China. It is treated as an independent species or conspecific with *H. barbatum* of Siberia, and the similar variation in the hairiness to that of *H. lanatum* is known. I am doubtful if this race should be regarded as a separate species from *H. lanatum*.

Lit. Hara in Bot. Mag. Tokyo 50: 419 (1936); Kitagawa in Rep. Inst. Sci. Res. Manch. 2: 273 (1938); Hiroe in Acta Phytotax. & Geobot. 14: 4 (1949).

**Ligusticum soethicum** L. .... **L. Hultenii** Fernald ————— *L. Hultenii*

Europe (Iceland, White	[Chukch, along coasts to Ussuri,	Aleut., Alaska, British Co-
Sea, along coasts to	n. Korea, Saghalien, Kuril., Kamt.,	lumbia

25) *Heracleum lanatum* var. *asiaticum* (Hiroe) Hara, stat. nov. — *H. lanatum* subsp. *asiaticum* Hiroe in Acta Phyt. & Geobot. 14: 4 (1949).



s. Sweden, England)	Yezo, n. Honshu (sea-coasts, prov. (2n=22))	Mutsu south to prov. Hitachi)	<i>L. scothicum</i> Labrador, along coasts south to New York; s. w. Greenland
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The Eastern Asiatic plant was recently transferred to *Angelica* by Hiroe.

Lit. Fernald in *Rhodora* 32: 7 (1930); Hara in *Bot. Mag. Tokyo* 50: 420 (1936); Hultén, *Fl. Aleut.* 249 (1937); Mathias & Constance in *N. Amer. Fl.* 28 B: 144 (1944); Hiroe in *Acta Phytotax. et Geobot.* 14: 29 (1949).

### **Pleurospermum**

**austriacum** ----- *P. austriacum*

(L.) Hoffmann	subsp. <b>uralense</b> (Hoffm.) Sommier
Europe (s. Sweden, c.	( <i>P. uralense</i> & <i>P. camtschaticum</i> Hoffm.)
Europe east to White	e. Europe (e. Russia), Siberia (east
Russia & Ukraine)	to Ussuri, Kamt.), n. Mongolia, Manch.,
	Korea, Saghal., Kuril., Yezo, n. & c. Honshu

The differences between the European and the Asiatic plants are pointed out by Hultén, and the Asiatic one is distinct in having markedly pointed lobes of leaves and very scabrous leaf-margins.

Lit. Hultén, *Fl. Kamt.* 3: 155 (1929); Horn af Rantzien in *Svensk Bot. Tidskr.* 40: 179 (1946).

<b>Sanicula europaea</b> L. ....	<b>S. elata</b> Hamilton .....	<b>S. canadensis</b> L.
Europe (2n=16), Caucasus, Asia Minor, Persia, C. Asia	Kashmir, India to China, Malaysia; Africa	South Dakota, Ontario to New Hampsh., south to Texas to Florida
	<b>S. chinensis</b> Bunge	
	( <i>S. elata</i> var. <i>chinensis</i> Makino)	<b>S. trifoliata</b> Bicknell
	Manch., China, Korea, Ussuri, s. Saghal., s. Kuril., Yezo, Honshu, Shikoku, Kyushu	Minn. to Quebec, south to Missouri, Tenn. & N. Carolina

Although the Japanese plants considerably vary in the serration of leaves, the length of rays, the length of calyces and styles, the size of fruits, and the density and length of prickles on the fruit, the treatment of Wolff, Shan and Constance in separating them into two species is hardly tenable, when abundant materials are examined, and they are nearer to *S. chinensis* than to *S. elata*.

The fruits are sessile, and 3-4 mm long and 1.5-2 mm wide excluding calyces and prickles; the calyx-lobes are linear-lanceolate (1) 1.2-1.8 (2.2) mm long and equal to or slightly exceeding the prickles; the styles are often slightly longer than the calyx and recurved in the upper part, and the pedicels of male flowers are ca. 1 mm long.

The plants of northern Japan referred to *S. chinensis* have usually styles equal to or slightly longer than the calyx, while some specimens, for example those from the vicinity of Tokyo, have longer styles almost twice as long as the calyx, and thus approach *S. elata* in this respect. The typical *S. chinensis* with compact inflorescences, larger fruits densely covered with rigid prickles,

longer calyces, and shorter styles, however, is also found in western Honshu, Shikoku and Kyushu. The plant from Mt. Amagi has slightly narrower lobes of leaves and smaller flowers, short styles, and fruits with more sparse prickles than the common form of *S. chinensis*.

*S. kaiensis* Makino & Hisauchi is localized on mountains (1000-2000 m high) of Prov. Shinano and Kai, and it differs from *S. chinensis* in having only 1-2 cauline leaves, male flowers with pedicels ca. 2 mm long, large fruits ca. 4 mm long armed with long rigid prickles which are distinctly inflated at the base, 5 large and several small vittae, calyx-lobes of perfect flowers strongly connate in the lower part, and styles long exserted from the calyx.

Lit. Wolff in Engler, Pfl.-reich IV-228, Ht. 61: 63 & 64 (1913); Hara in Bot. Mag. Tokyo 50: 423 (1936); Shan & Constance in Univ. Calif. Publ. Bot. 25 (1): 39 & 47 (1951).

**Seseli Libanotis** (L.) Koch - - - - *Seseli Libanotis*

(*Libanotis montana* Crantz) subsp. **japonica** (Boiss.) Hara<sup>26)</sup>

Europe (2n=22), Caucasus, (*S. ugoensis* Koidzumi)

Persia, Siberia; n. Africa s. Kuriles, Yezo, n. & c. Honshu

Compared with the European plants, the Japanese ones have generally tall and well branched stems, cauline leaves with less inflated narrow sheaths, no or a few involucre bracts, and ovaries with short papillae. The lower part of stems, and the nerves of leaves on the under surface are often covered with stiffer hairs. This plant, however, is polymorphous even in Japan, especially in the shape of leaflets and the density of hairs. Some specimens from Yezo have several involucre bracts, and ovaries densely covered with stiff hairs as in the European plants. A form with less incised broad and blunt lobes of leaves is often found near the sea-coasts. And the plants on mountains have generally finely dissected leaves, and some alpine specimens have inflated sheath of petioles and several involucre bracts. Although no Japanese specimen exactly agrees with the European, it is difficult to find decisive characters to separate them. Several allied species have been known from temperate Asia, and this group needs a monographic treatment.

Lit. Kitagawa in Bot. Mag. Tokyo 51: 657 (1937).

**Sium suave** Walter

*S. suave*

*S. suave*

(*S. cicutaefolium*

s. Siberia (east to Ussuri, Kamt.), n. & c.

Alaska, s. Mackenzie,

Schrank)

China, Manch., Korea, Saghal., Yezo, Honshu

British Columbia to

Rumania, central

(rare)

Newfld., south to Calif.

Russia

var. **nipponicum** (Maxim.) Hara

& Florida

(*S. nipponicum* Maxim.)

Manch., Korea, Yezo, Honshu, Shikoku,

Kyushu

26) *Seseli Libanotis* subsp. **japonica** (Boiss.) Hara, stat. nov. — *S. Libanotis* var. *japonica* Boiss. in Bull. Soc. Bot. France 55: 354 in nota (1909).

Lit. Wolff in Engler, Pfl.-reich IV-228, Ht. 90: 346 (1927); Hara in Journ. Jap. Bot. 16: 261 (1940); Mathias & Constance in N. Amer. Fl. 28 B: 152 (1944).

Lit. Hara in Bot. Mag. Tokyo 50: 424 (1936); Merrill in Rhodora 40: 291 (1938).

var. **ovatum** (Yatabe) Hara, comb. nov. — *S. ovatum* Yatabe in Bot. Mag. Tokyo 5: 73, t. 22 (1891). *S. nipponicum* var. *ovatum* (Yatabe) Yabe in Journ. Coll. Sci. Univ. Tokyo 16-2: 53 (1902).



The probable natural hybrid between *C. canadense* and *C. suecicum* is known under the name *C. unalaschkensis* Ledeb. from Alaska to British Columbia, Colorado, and Labrador to New Hampshire and Greenland, but has not been recorded from Eastern Asia. (To be continued)

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# Dicotyledonous Woods from the Miocene along the Japan-Sea Side of Honsyu\*

By

Shunji WATARI

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With 10 Photographs and 8 Figures in the Text

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Between north and southwest extremities of Honsyu, the Main Island of Japan, a considerable area along the coast of the Japan-Sea is covered interruptedly by the Tertiary deposits rich in pyroclastic rocks which are sometimes called the Green Tuff comprehensively and are referred by many geologists to the Middle to Lower Miocene chiefly from the stratigraphical point of view. These deposits contain everywhere an abundance of well-preserved silicified woods and my particular interest in an anatomical study on fossil woods is centered on them since 1941 when a considerable number of specimens were collected at two localities of Simane Prefecture including an area which is protected by law as a natural monument (loc. 64-a and b in Fig. 1).

Excepting a coniferous and several dicotyledonous species reported from these two localities in my last several papers (1948 a, b, 1949, 1951), our present knowledge concerning the fossil woods from these deposits as a whole is, as yet, so imperfect that we have only two species by other authors, namely *Ficoxylon angustiparenchymatosum* Shimakura (1937) from Tobisima I., Yamagata Prefecture (loc. 35-a in Fig. 1), and *Castanopsis Makinoi* Ogura (1949) from a northern part of Nagano Prefecture (indicated by × in Fig. 1). During the last few years, however, number of specimens from the same deposits of various localities have rapidly increased and the writer has found, until this date, a considerable number of species among them. Throughout these localities, dicotyledonous woods to which the present paper concern predominate in number of species and seven of them are described here as new species and six are referred or conferred to modern species although majority of them are also new as fossil. There are also found a lot of fossils which are referable to either species of already reported from Simane Prefecture and some other localities on the Pacific slope such as Anatai and Nezori, Iwate Prefecture (loc.

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\* Contributions from the Division of Plant-Morphology, Botanical Institute, Faculty of Science, University of Tokyo, N. S. No. 60.

31-a and b). These species were reported under form-genera in the previous papers, while they are transferred here to the modern genera so far as their anatomical features fall into the structural range of living representatives.

Although twenty-four species treated in the present paper are representing, of course, only a preliminary accounts of the fossils from these deposits and, in order to complete our knowledge, further extensive studies on these and other localities are naturally required, yet it should be noted that these contain a number of wide spreading species throughout these localities as well as many species which are likely to be indosed only by means of anatomical investigations of woods.

#### A short account of localities (cf. Fig. 1)

In the following lines, all localities concerning to the present paper, including a few on the Pacific slope, are explained together with brief geological notes and, in addition, all species of Dicotyledons obtained from respective prefectures are also listed for the convenience sake of a comparison.

**Akita Prefecture (34).** (a) Sinzan, Kitaura-mati, Minami-Akita-gun (Oga Peninsula)<sup>1)</sup>. Only a single specimen was obtained, probably from Sugoroku or Daijima Group (cf. Huijoka 1950).

##### *Ulmus crystallophora* Watari

**Yamagata Prefecture (35).** (a) Tobisima I., Akumi-gun<sup>2)</sup>. Among boulders on the beach called Sai-no-Kawara, were obtained 5 specimens including 3 dicotyledonous woods probably derived from a green tuff lying on the sea floor of the coast. In the same locality, *Ficoxylon angustiparenchymatosum* Shimakura (1937) was dredged. (b) Aburato, Kamo-mati, Nisi-Tagawa-gun<sup>3)</sup>. Tertiary tufaceous deposits, consisting chiefly of an alternation of shale, sandstone and conglomerate, are exposed on the cliff along the beach, extending ca. 12 km southwards from the vicinity of Yunohama Hot Spring to Yura, Toyouramura. Fossil woods are most abundant in tufaceous sandstone at the environs of Aburato, a small village situated about midway of the long stretching cliff, and its south. Of 26 specimens, 5 are Dicotyledons. (c) Iragawa, Atumi-mati, Nisi-Tagawa-gun<sup>4)</sup>. About 20 specimens including at least 8 dicotyledonous woods were obtained from an alternation of tufaceous shale and sandstone at the vicinity of the Iragawa Colliery. (d) Isagodani, Tagawa-mura, Nisi-Tagawa-gun<sup>5)</sup>. Reddish to purple coloured tuff and tuff-breccia contain fossil woods abundantly. In this village, a lot of them is used for ornamental stones of gardens, stone-walls, base-stones of houses, stepping-stones and sometimes even for weight of such roofing materials as shingles, shakes or barks of *Cryptomeria*. Of 55 specimens, 12 are Dicotyledons. (e) Yutagawa Hot Spring,

1) 南秋田郡北浦町眞山宇鳥井下 2) 飽海郡飛島 3) 西田川郡加茂町油戸 4) 西田川郡温海町五十川 5) 西田川郡田川村砂谷



Yutagawa-mura, Nisi-Tagawa-gun<sup>1)</sup>. Some fragments were obtained from 3 ornamental stones of a garden; their exact origin are unknown, probably transferred from the locality (d). (f) South-west suburb of Turuoka City (near Yutagawa Hot Spring)<sup>2)</sup>. Only a single specimen was obtained from a

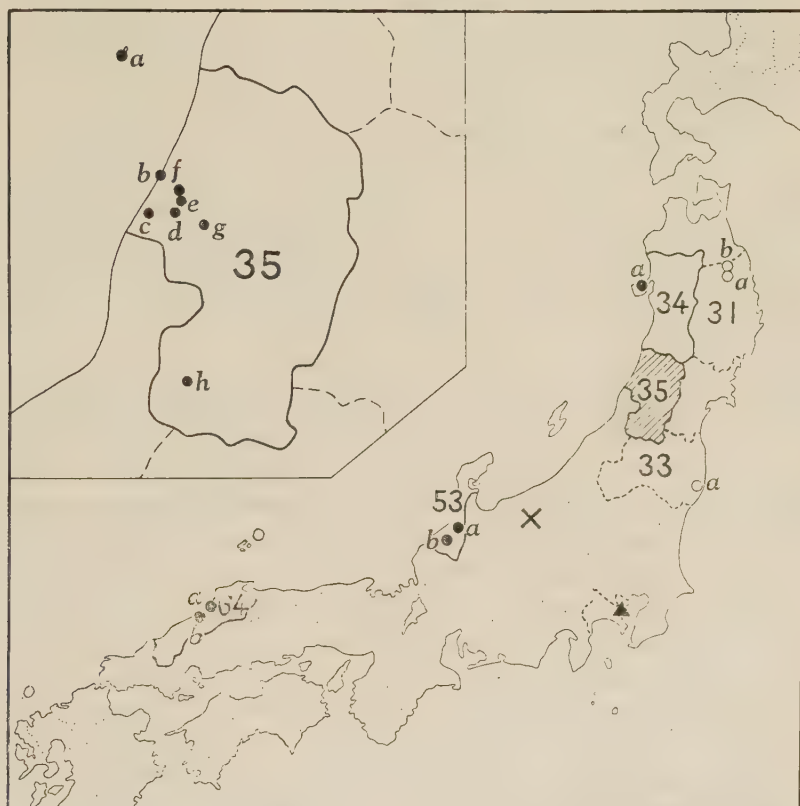


Fig. 1. Map showing the localities in the text. Numerals are conventional number of prefectures, 31 Iwate, 33 Fukushima, 34 Akita, 35 Yamagata, 53 Isikawa, and 64 Simane Prefectures respectively; black spots with alphabets in small letter indicate localities of the Japan-Sea side (cf. explanations on localities on p. 98 sqq.).

reddish-brown coloured tuff. (g) Tamugimata, Azuma-mura, Higasi-Tagawa-gun<sup>3)</sup>. Andestic agglomerate and tuff contain fossil woods. Of 17 specimens, 14 are Dicotyledons. (h) Kanomizu, Tugawa-mura (near Oguni-mati), Nisi-Okitama-gun<sup>4)</sup>.

1) 西田川郡湯田川湯田川村温泉    2) 鶴岡市西南郊外    3) 東田川郡東村田麥俣

4) 西置賜郡津川村叶水

Dicotyledonous woods obtained from these localities are as follows:

<i>Carya protojaponica</i> Watari	(a, d)
<i>Pterocarya rhoifolia</i> Sieb. et Zucc.	(g)
<i>Quercus anataiensis</i> (Watari) Watari	(b, g, h)
<i>Zelkova zelkoviformis</i> (Watari) Watari	(a, b, d)
<i>Laurinum machiliforme</i> Watari	(g)
<i>Liquidambar formosana</i> Hance	(c, d, f, g)
<i>Gleditsia</i> cfr. <i>japonica</i> Miquel	(g)
<i>Acer</i> cfr. <i>amoenum</i> Carr.	(d)
<i>Reevesia miocenica</i> Watari	(c, d, g)
<i>Elaeagnus semiannuliporosa</i> Watari	(a, d, e)

Remarks:—Mr. Toshimasa Tanai, by whose effort our knowledges in the stratigraphy of the Nisi-Tagawa Coal Field is markedly promoted, divides the Tertiary deposits of the locality (b) into Kamo Formation and Sanze Formation and correlate them to the Daijima Group and Sugoroku Group of Oga Peninsula respectively (Tanai, 1951). Also according to Mr. Tanai, localities (c) and (h) are probably correlate to Daijima Group, while (d), (e) and (f), to Sugoroku Group.

**Isikawa Prefecture (53).** (a) Sodani, Hayasi-mura, Isikawa-gun<sup>1</sup>). Fossil woods were abundantly found among boulders in a small valley. In a branch valley, near the north boundary of the village, are found several fossils, a few being exposed from a green tuff. All fossils probably eroded out from this deposit. Of 40 specimens, at least 27 are Dicotyledons. (b) Nata-mura, Enuma-gun<sup>2</sup>). A single specimen was obtained from a stone pit in a green tuff.

The following 6 species are found.

<i>Carya protojaponica</i> Watari	(a)
<i>Carpinus laxa</i> Watari	(a)
<i>Quercus anataiensis</i> (Watari) Watari	(a)
<i>Ulmus crystallophora</i> Watari	(a)
<i>Liquidambar formosana</i> Hance	(a, b)
<i>Hovenia dulcis</i> Thunberg	(a)

Remarks:—A geological map prepared by the Government of the Isikawa Prefecture (1951) shows that green tuff of these localities belongs to the Lower Miocene.

**Simane Prefecture (64).** (a) Hanenisi, Kute-mati, Anno-gun<sup>3</sup>). Many fossil woods are exposed on the beach from a tuff-breccia and are protected by law as a natural monument. Some 15 specimens from this locality are all Dicotyledons. (b) Nima-mati, Nima-gun<sup>4</sup>). On a cliff along the beach, many fossil woods are exposed from a tuff-breccia in two places, Taziri and Sakanada, ca. 800 m apart each other. Of 40 specimens, 36 are Dicotyledons.

1) 石川郡林村曾谷 2) 江沼郡那谷村 3) 安濃郡久手町波根西 4) 通摩郡仁万町  
田尻及び坂灘

From these two localities, are found following 13 species including some already reported (Watari 1948 a, 1949, 1951).

<i>Carya protojaponica</i> Watari	(a)
<i>Pterocarya rhoifolia</i> Sieb. et Zucc.	(b)
<i>Betula hanenisiensis</i> (Watari) Watari	(a, b)
<i>Quercus</i> cfr. <i>acuta</i> Thunberg	(b)
<i>Zelkova Wakimizui</i> (Watari) Watari	(a)
<i>Zelkova zelkoviformis</i> (Watari) Watari	(b)
<i>Laurinium iwamiense</i> Watari	(a)
<i>Laurinium kuteense</i> Watari	(a)
<i>Liquidambar formosana</i> Hance	(a, b)
<i>Meliosma Oldhami</i> Miquel	(b)
<i>Leea eo-japonica</i> Watari	(b)
<i>Cornus simanensis</i> (Watari) Watari	(a)
<i>Paulownia hondoensis</i> (Watari) Watari	(a)

Remarks:— In a private communication, Prof. Sotoji Imamura of the University of Hiroshima, who is engaging in an extensive study in the stratigraphy of these area, kindly informed me that these deposits are probably possible to correlate to the Oomori Group (Tomita and Sakai, 1938) of Izumo Province, Simane Prefecture.

Finally, explanations for the following localities on the Pacific slope are added here for the sake of convenience, as the majority of species already reported from Iwate Prefecture (Watari 1941 a, b) are repeatedly found from the deposits mentioned above, and a new species from Fukusima Prefecture is found too from Akita and Isikawa Prefectures on the Japan-Sea side.

**Iwate Prefecture (31).** (a) Anatai-mura, Ninohe-gun<sup>1)</sup>. Some 20 specimens including 8 dicotyledonous woods were obtained from a tuff (prob. Lower Miocene). (b) Nezori, Namiuti-mura, Ninohe-gun<sup>2)</sup>. About 25 specimens including 8 diocyledonous woods were obtained from a tufaceous sandstone (prob. lower part of the Middle Miocene).

From these localities, the following 6 species were reported, most of which are represented by the modern genera in the present paper: *Carya protojaponica* Watari (a), *Fagus hondoensis* (Watari) Watari (b), *Quercus anataiensis* (Watari) Watari (a), *Zelkova zelkoviformis* (Watari) Watari (a), *Laurinium machiliforme* Watari (a), and *Acer iwatense* (Watari) Watari (b).

**Fukusima Prefecture (33).** (a) Isimoriyama, Kabeya-mura, Isiki-gun (near Taira City)<sup>3)</sup>. A single specimen from an agglomerate of the Misawa Formation, Sirado Group (Middle Miocene) is described below as a new species, *Ulmus crystallophora* Watari.

1) 二戸郡姉帯村    2) 二戸郡浪打村根反    3) 石城郡神谷村石森山



## Descriptions

### 1. *Carya protojaponica* Watari, sp. nov. (Photo. 1)

*Juglandinium* sp. Watari in Jap. Jour. Bot. 11: 397-399, fig. 3, 1941a (Anatai, Iwate-Pref. (31-a); No. 31138).

Occurrence. (1). Tobisima I, Yamagata Pref. (35-a); No. 35103, collected by Dr. Masami Sato in 1949. (2). Isagodani, Yamagata Pref. (35-d); Nos. 35066, 35070, 35074, fairly deformed specimens, but details are excellently preserved in No. 35070, descriptions chiefly based on this specimen; collected by the writer in 1950. (3). Sodani, Isikawa Pref. (53-a); Nos. 53526, 53532, 53538; collected by the writer in 1951. (4). Hanenisi, Simane Pref. (64-a); No. 64409, markedly deformed but minute structures are well-preserved; collected by the writer in 1941.

Description. Wood mostly semi-ring porous to decidedly ring-porous, occasionally also nearly diffuse porous. Growth rings distinct, delineated by a narrow band of flattened elements. Pores solitary and in multiples of 2-several which further show more or less distinct diagonal arrangement; solitary pores circular to oval in outline, up to 160-220 (300) microns in maximum tangential diameter; common walls of multiples much thickened. Vessel segments 110-450 microns in length; perforation plates slanting and exclusively simple; intervessel pits alternate, circular or not infrequently angular by mutual contact, large, mostly 7-12 microns in diameter, pit apertures elliptical to lenticular; thin-walled tyloses abundantly present. Fiber tracheids forming ground mass, arranged in regular radial rows, polygonal with rounded corners, walls rather thin to moderately thickened, 15-25 microns in diameter. Parenchyma vasicentric, metatracheal, metatracheal-diffuse and terminal; vasicentric parenchyma forming frequently associated with metatracheal one a narrow sheath about pores; metatracheal parenchyma uniseriate or in part biseriate, forming very distinct and occasionally somewhat wavering patterns; diffuse parenchyma sparse; terminal parenchyma uniseriate; crystalliferous elements quite frequent, much swollen and easily discernible even in cross sections, 1-several in a vertical series. Rays homogeneous to decidedly heterogeneous, 1-2, very rarely 3 or 4, cells wide; uniseriate rays mostly 1-20 cells high; multiseriate rays linear to narrow fusiform, uniseriate margins more or less well-developed, sometimes exceeding 10 or more cells in height, consisting entirely of squarish cells or frequently provided with 1-2 layers of marginal upright cells; procumbent cells round or polygonal in tangential section; pits into vessels chiefly round to oval, half-bordered and arranged alternately in 1-3 horizontal rows.

Affinity. In determining the present fossil, there are many salient features, that is, the semi-ring porosity which frequently tend to be decidedly ring porous, solitary pores and multiples of 2-several which further show more or less distinct diagonal arrangement, vessel segments with exclusively simple perforations, frequent occurrence of the thin-walled tyloses, alternate and frequently angular large intervessel pits, imperforate tracheary elements of

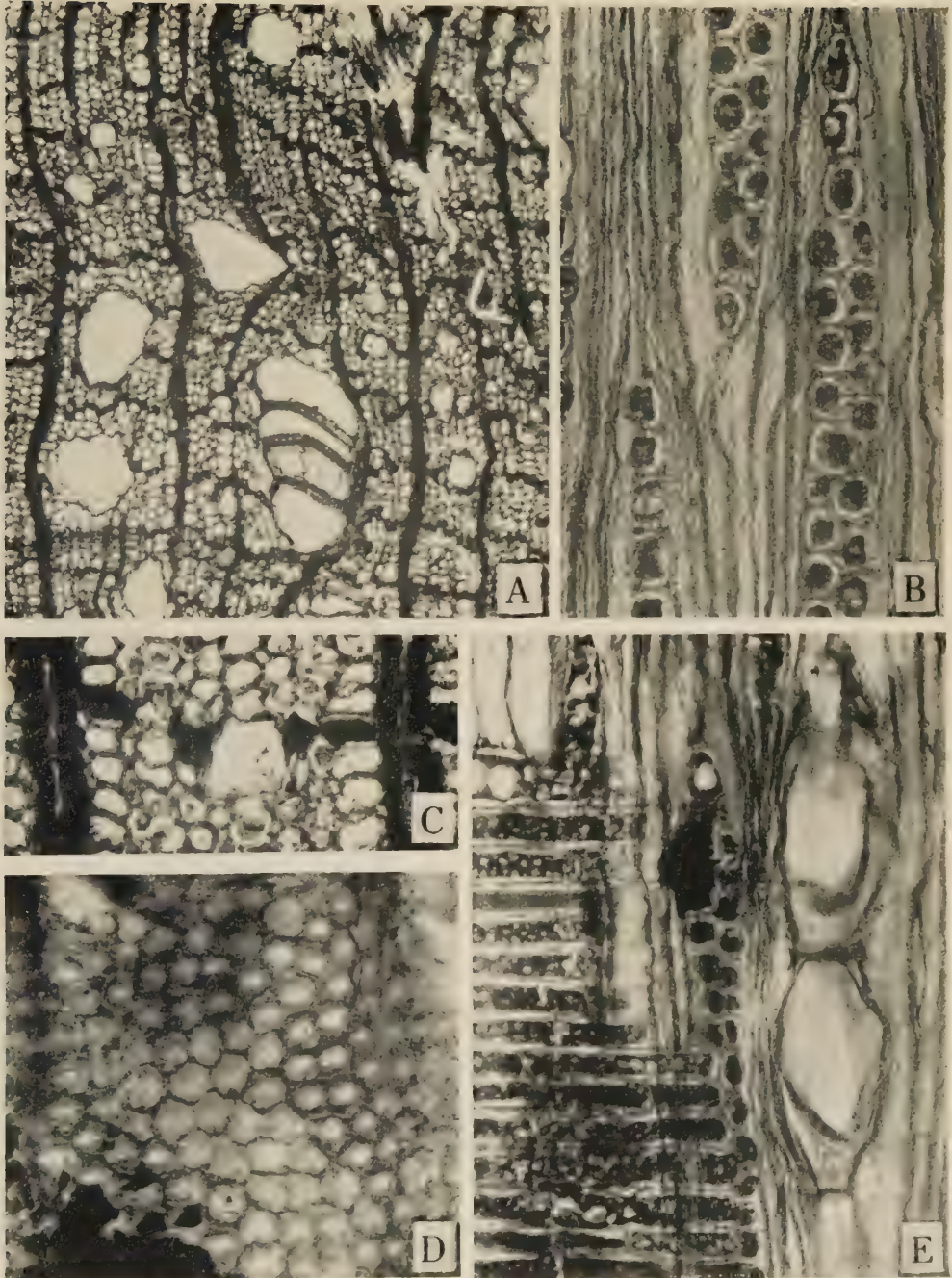


Photo. 1. *Carya protojaponica* Watari, sp. nov. A, cross section showing a boundary of growth rings, a multiple with thickened common walls and concentric bands of metatracheal parenchyma with crystalliferous elements (cf. C) ( $\times 80$ ). B, tangential section showing a few uniseriate and biseriate rays ( $\times 400$ ). C, a metatracheal band with a swollen crystalliferous element under a higher magnification ( $\times 300$ ). D, angular intervessel pits ( $\times 600$ ). E, swollen crystalliferous elements in a longitudinal section; a mixed view of tangential and radial sections of one and the same ray is observable by a folding of the tissue ( $\times 300$ ).



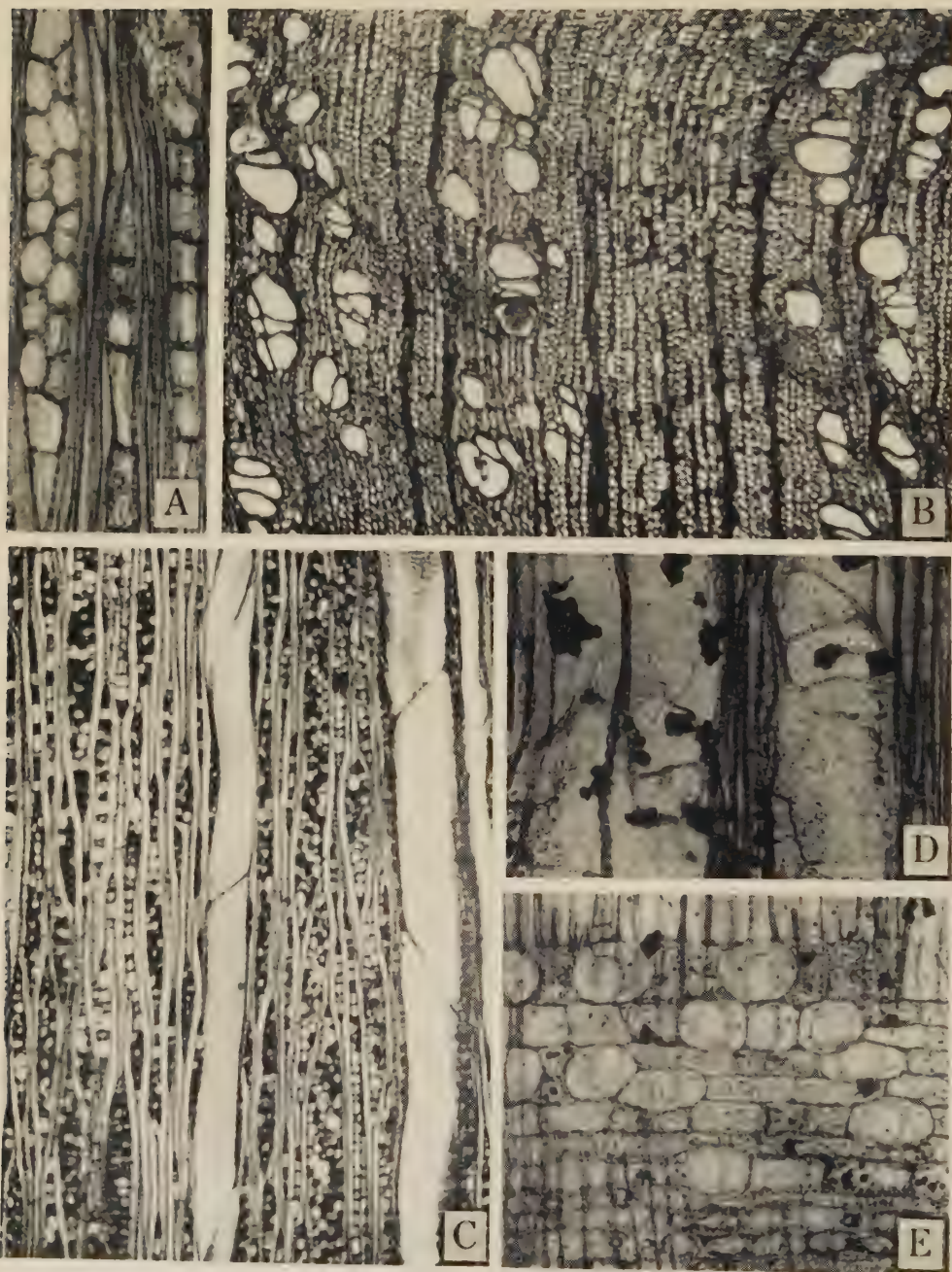


Photo. 2. A, *Pterocarya rhoifolia* Sieb. et Zucc., a few uniseriate and biseriate rays in a tangential section ( $\times 400$ ). B–D, *Carpinus laxa* Watari, sp. nov. B, cross section with a boundary of growth rings, showing three radial patches of pores interrupted by aggregate rays, and uniseriate bands of metatracheal parenchyma ( $\times 80$ ). C, tangential section showing part of two aggregate rays and two vessels ( $\times 80$ ). D, radial section showing two scalariform perforation plates, one on the left side with one, and another on right side with two bars ( $\times 200$ ). E, radial section showing a part of ray with many swollen crystalliferous elements ( $\times 200$ ).

fiber tracheids category, presence of very distinct metatracheal and terminal parenchyma which are mostly in uniseriate bands, frequent occurrence of the swollen chambered parenchyma and decidedly heterogeneous rays. An assortment of these features seems to dictate that the present fossil is a member of the Juglandaceae.

There are six genera in the family, but three of them are easily distinguishable from the present fossil, that is, *Alfaroa* and *Engelhardtia* by the possession of simple-scalariform perforations, and *Platycarya*, by the presence of flame-like groups of small vessels in the latewood. In *Juglans* rays are usually broader and no species show a decided ring porosity though most of them sometimes tend to be semi-ring porous. In *Pterocarya*, most species show a diffuse porosity excepting *P. Paliurus* which shows occasionally a tendency toward ring porosity, and swollen crystalliferous elements seem to be absent in all species.

Most species of the genus *Carya* predominantly show a decided ring porosity as is frequently observed in this fossil. The shortest length of vessel segments ever known among the family, much thickened common walls of pore multiples, the occurrence of markedly swollen chambered parenchyma, and the rays which show frequently a decided heterogeneity are considered to be additional evidences supporting the affinity to *Carya*. This genus comprises of about twenty species from North America, one from China (*C. catheyensis* Sargent) and one from Indo-China (*C. tonkinensis* H. Lecomte). Although some features of the present fossil resemble to Asiatic species rather than North American plants, *C. catheyensis* lacks crystalliferous elements in parenchyma though rays are narrow (1-2 cells wide) (Tang 1936), while *C. tonkinensis* possesses broader rays (1-5 cells wide) though the chambered parenchyma is quite abundant (Kribs 1927 and 1928; Wetmore and Heimsch 1939). Thus, as no modern species seem comparable to the present fossil as well as the fossil forms hitherto described (cf. Watari 1941 a), the writer proposes here a new name *Carya protojaponica* Watari.

## 2. *Pterocarya rhoifolia* Sieb. et Zucc. (Photo. 2 A; Fig. 2)

Occurrence. (1). Tamugimata, Yamagata Pref. (35-g); No. 35201, rather poorly preserved specimen; collected by Dr. Masami Sato in 1950. (2). Taziri, Nima, Simane Pref. (64-b); No. 64511, fairly deformed but minute structures preserved well in some places; collected by the writer in 1941.

Description. Wood diffuse porous with a tendency of diagonal arrangement which is especially distinct in the latewood of broader rings. Growth rings distinct by the presence of narrow zone of flattened elements on the outer margin of the ring. Pores solitary and in multiples of 2-several, decreasing gradually in size through latewood; large solitary pores of earlywood oval, up to 220 microns in maximum tangential diameter, smaller vessels more or less



angular; all thin-walled. Vessel segments 230-550 microns in length; perforation plates simple and slanting; intervessel pits alternate or somewhat irregular in arrangement, large, 8-12 microns in horizontal diameter, usually angular by mutual contact, pit apertures oval to elliptical and horizontal; thin-walled tyloses fairly abundant. Fiber tracheids arranged in regular radial rows, rarely



Fig. 2. *Pterocarya rhoifolia* Sieb. et Zucc., cross section through a small part of wood containing a boundary of growth ring showing 5 solitary pores and a multiple with tyloses, uniseriate bands of terminal and metatracheal parenchyma, some diffuse parenchyma, and several uniseriate and biseriate rays (ca.  $\times 100$ ).

septate, 15-25 microns in diameter, polygonal in outline, walls fairly thin excepting a few marginal flattened elements; pits circular, 4-5 microns in diameter, pit apertures lenticular, screw-headed or included, vertical or nearly so. Parenchyma metatracheal and terminal; uniseriate bands of metatracheal parenchyma very prominent, frequently in fairly long, somewhat wavering tangential rows; terminal parenchyma uniseriate and continuous; chambered parenchyma entirely absent. Rays nearly homogeneous to decidedly heterogeneous, 1-2 cells wide; uniseriate rays linear, mostly 2-25 cells or up to 340 microns high; biseriate rays also linear, usually flanked by uniseriate wings of a few to several cells high; procumbent cells all vertically elongated in tan-

gential section, angular and rarely with rounded corners; pits into vessels half-bordered, oval, 6-8 microns in horizontal diameter, arranged alternately in 1-3 (4) horizontal rows.

Affinity. As is shown in the preceding description, general features apparently show that the present fossil is also a member of the Juglandaceae, especially close to *Pterocarya* or certain non-crystalliferous species of *Juglans*, e.g., *Juglans cinerea*. The rays of *J. cinerea*, however, are 1-4 seriate, while in the fossil they are constantly uniseriate or biseriate which seems a prevailing feature fairly universal to *Pterocarya*. After a careful comparison with the description on several species of *Pterocarya* as well as writer's own observation on some of them, he found that there is a perfect identity between the present fossil and *Pterocarya rhoifolia* Sieb. et Zucc. which is now distributed in Japan and in a limited area of North Eastern China (Shantung).

### 3. *Betula hanenisiensis* (Watari) Watari, comb. nov.

*Betulinium hanenisiense* Watari in Jap. Jour. Bot. 13: 503-506, figs. 1, 2, Photo. 1 A, 1948 (Hanenisi, Simane Pref. (64-a); No. 64108).

Occurrence. (1). Sakanada, Nima, Simane Pref. (64-b); Nos. 64532, 64539, well-preserved large silicified woods; collected by the writer in 1941.

### 4. *Carpinus laxa* Watari, sp. nov. (Photo. 2 B-E; Fig. 3)

Occurrence. (1). Sodani, Isikawa Pref. (53-a); Nos. 53501, 53540, preservation of internal structure especially excellent in No. 53540, description chiefly based on this specimen; collected by the writer in 1951.

Description. Radial porous wood with aggregate rays. Growth rings markedly sinuous, faintly distinct by the presence of a few layers of flattened elements on the outer margin of the ring. Pores aggregate to form narrow to broad radial patterns in varying width; solitary and more frequently grouped in multiples of 2-several with occasional clusters; solitary pores circular to oval, up to 110 microns in maximum tangential diameter, thin-walled. Vessel segments 350-850 microns in length; perforation plates slanting and scalariform with 1-4 (5), rarely ramified and widely spaced, stout bars or rarely simple; intervessel pits circular, oval or more frequently angular by mutual contact, 6-10 microns in diameter, pit apertures lenticular and horizontal; fine spirals or striations faintly distinct in some places. Non-perforate tracheary elements tracheids and fiber tracheids; tracheids vasicentric and scarce, with fine spiral thickenings; fiber tracheids forming ground mass, arranged in regular radial rows, polygonal with moderately thickened walls, 10-15 microns in diameter. Parenchyma metatracheal, metatracheal-diffuse and terminal; metatracheal parenchyma forming slightly wavering uniseriate bands which are especially distinct in latewood; diffuse parenchyma scarce; terminal parenchyma uniseriate. Rays heterogeneous, 1-3 (5) cells wide, some grouped in somewhat loosely defined aggregate rays; linear to narrow fusiform provided

with uniseriate wing consisting mostly of 1 layer of marginal upright cells and squarish cells grading into typical procumbent cells of the multiseriate part; all walls fairly thickened; crystalliferous elements very abundant and easily discernible even in cross sections, much swollen and oval in radial section, frequently crowded or aggregate in uniseriate wing, individual elements 45–85 and 30–45 microns in radial and vertical diameters respectively; pits into vessels quite similar to intervessel pits.

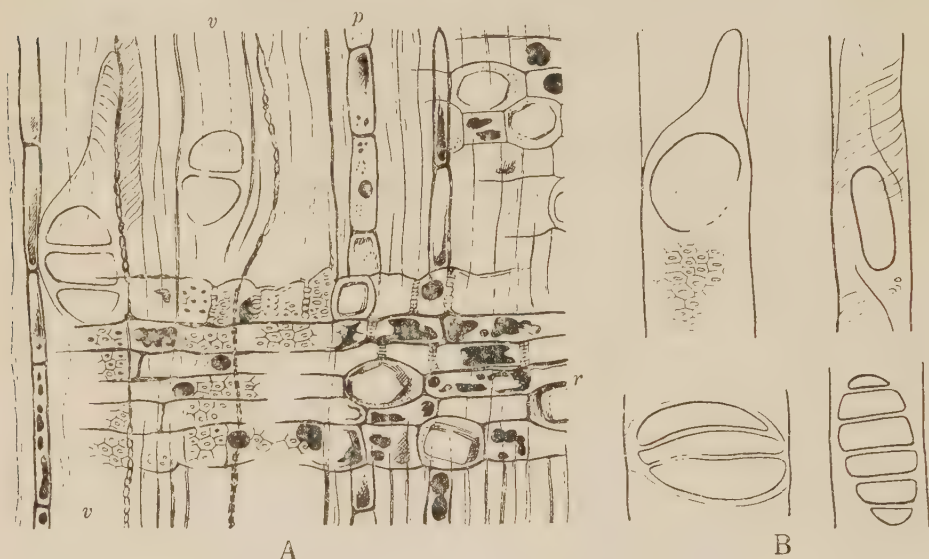


Fig. 3. *Carpinus laxa* Watari, sp. nov. A, radial section showing a few vessels *v* with scalariform perforation plates with 1 and 2 stout bars respectively, parenchyma strands *p*, heterogeneous ray *r* with a layer of upright cells on the margin and swollen crystalliferous elements, and angular pits between ray and vessels. ( $\times 200$ ). B, 2 simple perforation plates and 2 scalariform ones with 2 and 5 bars respectively ( $\times 200$ ).

**Affinity.** Radial porosity with frequent occurrence of pore-multiples, presence of rather loosely defined aggregate rays, and well-marked uniseriate bands of metatracheal parenchyma, are most important characteristics of the genus *Carpinus*. Previous descriptions covering a considerable number of the genus (Kanehira 1921 a, b; Yamabayashi 1938; Tang 1936; Brown, Panshin and Forsiath 1949; etc) as well as my critical observations on Japanese species show, though there are some inconsistency of observation<sup>1)</sup>, that in the species

1) Although Kanehira (1921 a) described scalariform perforation with 3–7 bars in *Carpinus laxiflora* Blume (sect. *Eucarpinus*), they are always simple in our reliable materials, showing an identity with the description of Yamabayashi (1938). Tang (1936) also shows simple perforation in *C. laxiflora* var. *macrostachya* Oliv. On the other hand, according to Tang, perforations are simple in *C. polyneura* Franch., whereas they are scalariform with 4–15 bars in *C. polyneura* var. *Wilsoniana* Wink. The latter case probably due either to an erroneously labelled specimen or misidentification of the plant.



belonging to the sect. *Eucarpinus* perforations are exclusively or predominantly simple, while in the sect. *Distegocarpinus* they are exclusively scalariform. Number of bars in systematically important species of the latter section, i. e., *C. cordata* Blume, *C. japonica* Blume and *C. rankanensis* Hayata are described by Kanehira (1921 a) as 4-14, 2-6 and 4-8 respectively. In my own observation, there are 3-10 (14) bars in *C. cordata* and 4-9 (12), in *C. japonica*. Anyhow, there seems no living representatives characterized by scalariform perforations with such a small number of bars (1-4) associated with rare occurrence of simple perforations as in the case of present fossil.

On the other hand, presence of crystalliferous elements in rays is a prevailing feature among this genus. In *C. cordata* and *C. japonica* they are fairly abundant, being scattered here and there in a microscopic field, but difference of the shape between crystalliferous and non-crystalliferous elements is rather slight. In *C. laxiflora* and *C. Tschonoskii* of the sect. *Eucarpinus*, the elements are larger and markedly swollen but they are more scarce than the above-mentioned two species. In *C. laxiflora*, even they are sometimes entirely absent in a given section. In the fossil, they are fairly similar to the first one in size, but their swollen outline is rather identical to the latter. Beyond this, however, the crowded or aggregate occurrence of such elements gives another outstanding feature to this fossil.

These natures somewhat intermediate between those of two existing sections, especially a particular type of the perforation, further suggest that this fossil should possibly represents an ancestral form of the sect. *Eucarpinus*, if we may suppose that the branch of the sect. *Eucarpinus* arose during the course of evolution on the phylogenetic line, direct descendants of which are represented by the sect. *Distegocarpinus*, an undoubtedly more primitive group on the basis of wood anatomy. Moreover, there are no fossil forms comparable to the present one, though several species have been reported under *Carpinoxylon* and *Carpinus* (cf. Edwards 1931). Taking up the scarcity of bars of the scalariform perforations with rare occurrence of simple type and striking abundance of much swollen crystalliferous elements of the rays as important characteristics, the writer proposes here a new name *Carpinus laxa* Watari.

##### 5. *Fagus hondoensis* (Watari) Watari, comb. nov.

*Fegonium hondoense* Watari in Jap. Jour. Bot. 11: 427-431, figs. 2, 3, Photo. 2, 1941 b (Nezori, Iwate Pref. (31-b); Nos. 31101, 31103-31105, 31123, 31125).

##### 6. *Quercus* cfr. *acuta* Thunberg (Photo. 3 A-D; Figs. 4, 5)

Occurrence. (1). Taziri, Nima, Simane Pref. (64-b); No. 64512, a fragment of large silicified wood, preservation rather poor; collected by the writer in 1941.

Description. A radial porous wood with compound rays. Growth rings faintly distinct, breadth variable. Pores arranged in 1-2(3) radial rows, soli-

tary and very rarely 2 in radial, tangential or diagonal groups, decreasing very slightly in size toward the outer margin of the ring or invariable, walls fairly thickened; solitary pores circular or oval, up to 260 microns in maximum tangential diameter. Vessel segments 200–720 microns in length; perforation plates simple and slanting at a variable angle; pits on lateral wall alternate, round to oval in outline, 6–9 microns in diameter; thin-walled tyloses abundantly present. Non-perforate tracheary elements tracheids and fibers; tracheids present at least in the form of vasicentric tracheids; fibers forming the ground mass, arranged in somewhat regular radial rows or irregular, polygonal or squarish, 14–30 microns in diameter and 3–5 microns in wall-thickness. Parenchyma vasicentric and metatracheal; vasicentric parenchyma scarce, intermingled with tracheids; metatracheal parenchyma 1–2 (3) layered, forming more or less wavering bands; chambered parenchyma frequent, crystal polygonal, frequently 10 or more somewhat swollen crystalliferous elements arranged in a vertical

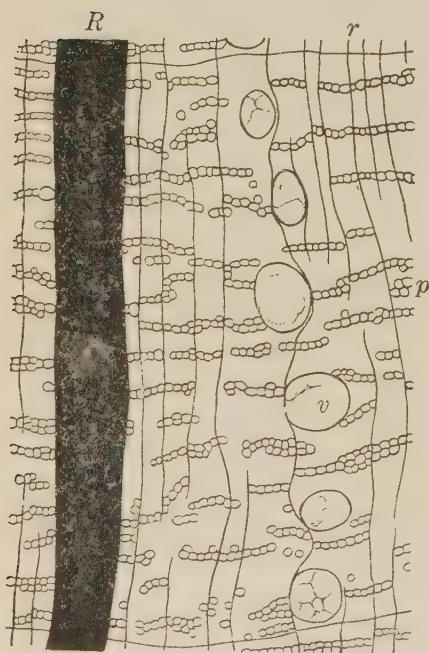


Fig. 4. *Quercus* cf. *acuta* Thunberg, a half-schematic figure showing radial arrangement of pores *v* with tyloses, tangential bands of metatracheal parenchyma *p*, a compound ray *R*, and many uniseriate rays *r* ( $\times 50$ ).

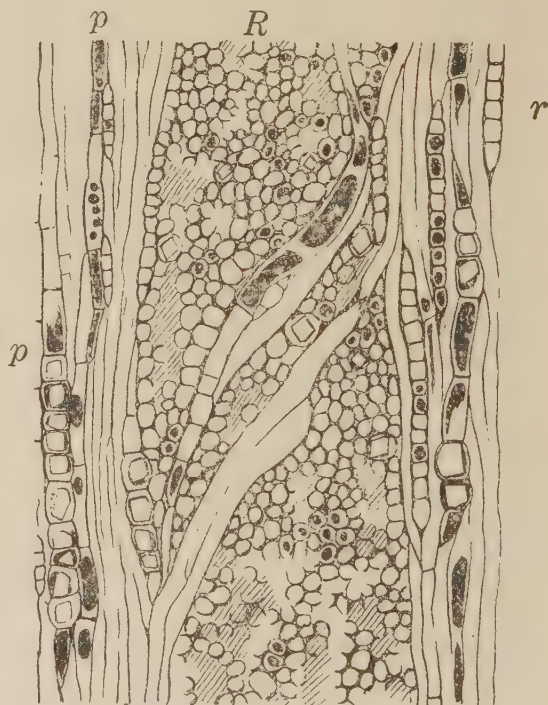


Fig. 5. *Quercus* cf. *acuta* Thunberg, tangential section showing several parenchyma strands *p* with swollen crystalliferous elements, a few uniseriate rays *r*, and part of a compound ray *R* with some vertical elements ( $\times 100$ ).



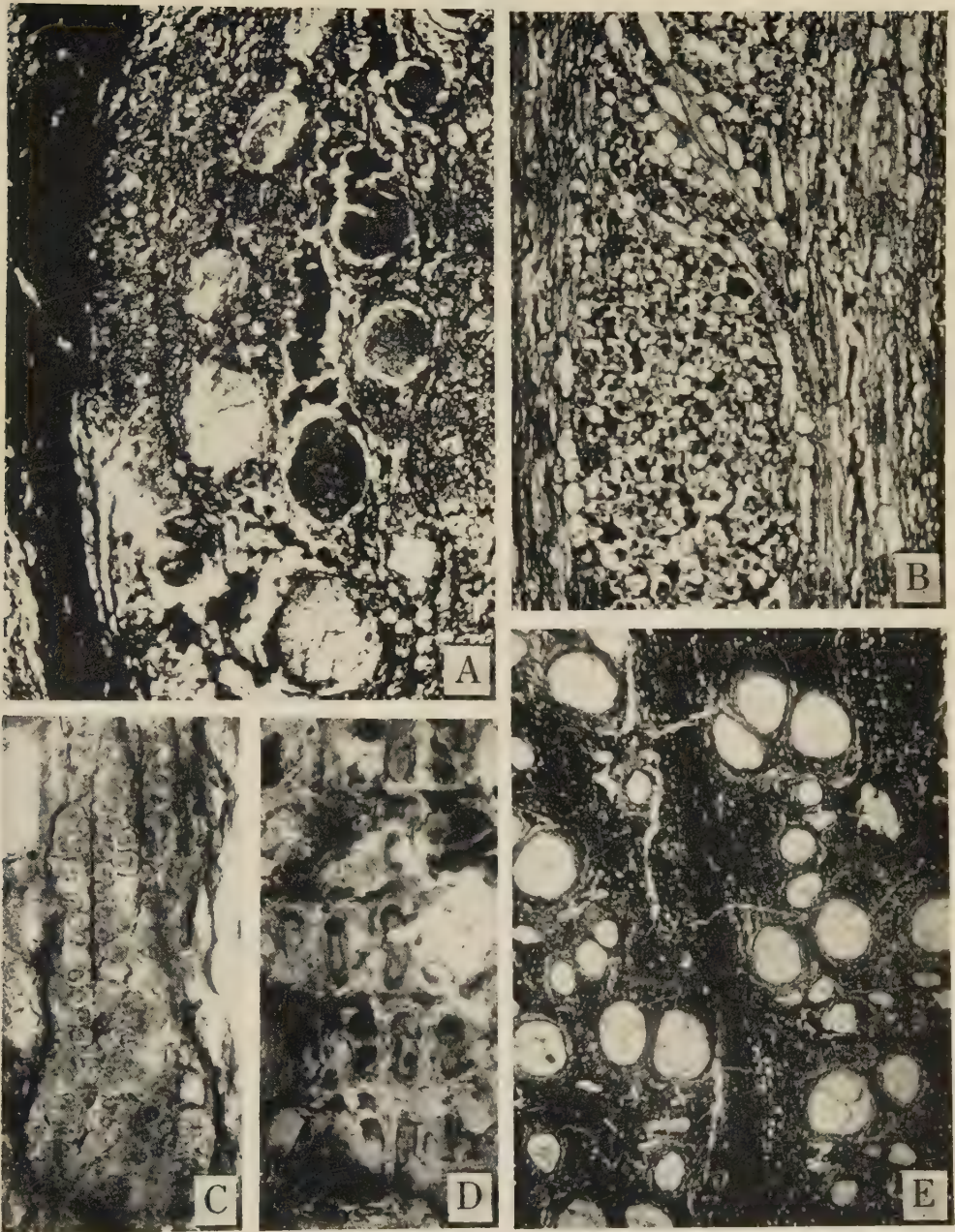


Photo. 3. A-D, *Quercus* cfr. *acuta* Thunberg. A, cross section showing a compound ray and two radial rows of pores ( $\times 80$ ). B, tangential section showing a part of a compound ray ( $\times 80$ ). C, a few vasicentric tracheids in a longitudinal section ( $\times 350$ ). D, characteristic palisade-like pits between ray and vessel ( $\times 800$ ). E, *Quercus anataiensis* Watari, cross section showing arrangement of pores and a compound ray (No. 53509 from Sodani, Isikawa Pref.) ( $\times 15$ ).



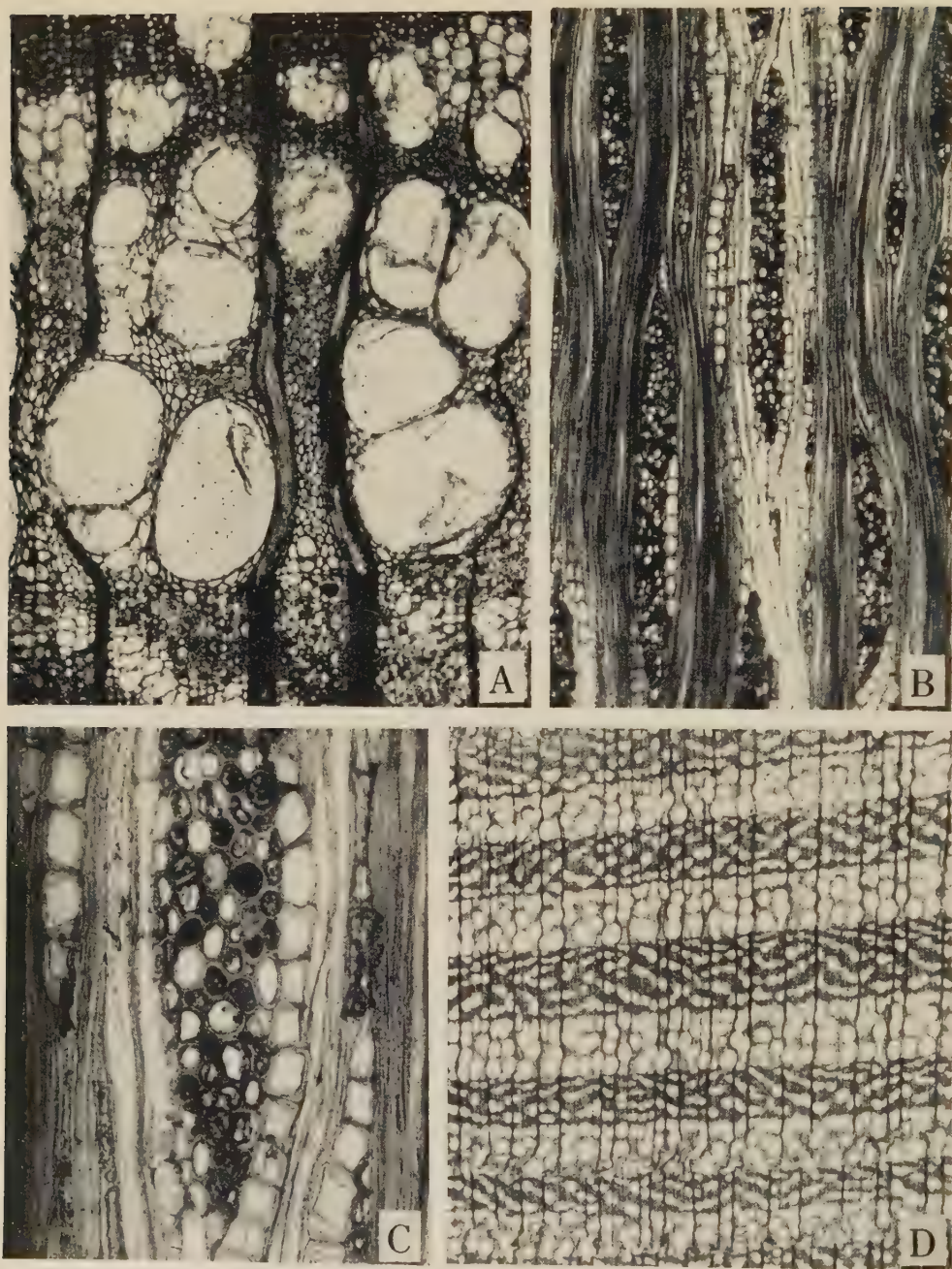


Photo. 4. *Ulmus crystallophora* Watari, sp. nov. A, cross section showing a boundary of growth rings, large pores of the earlywood and groups of smaller vessels on the upper and lower sides of the figure ( $\times 80$ ). B, tangential section showing several multiseriate rays, fibers, and several long vertical series of chambered parenchyma ( $\times 80$ ). C, a part of B under a higher magnification showing a part of homogeneous ray and 3 chambered parenchyma ( $\times 300$ ). D, cross section under a low magnification showing an abrupt transition between the early- and latewood ( $\times 8$ ).

series. Rays homogeneous, narrow and compound; narrow rays uniseriate or rarely in part biseriate; 1-28 cells or 38-600 microns in height, individual elements squarish or more or less rounded in tangential section; compound rays 11-36 cells or 190-620 microns wide and very high, elements 8-35 microns in diameter; somewhat swollen crystalliferous elements abundant, a few to several in a radial series; pits into vessels elliptical, 3-7 and 10-20 microns in short and long diameters respectively, usually palisade-like in arrangement.

Affinity. Radial patches consisting of a few rows of pores which are invariable in size or decreasing but very slightly toward the outer margin of the ring and an abundance of the compound rays, these particular features of this fossil show an undoubted affinity to the members of sect. *Cyclobalanopsis* of the genus *Quercus*. Some species of this section, however, really so resembles each other in their wood structure, that they can hardly be separated with certainty on the basis of anatomical criteria which are ordinarily used by most investigators. However, so far as the writer is aware, chambered parenchyma in such a long series, frequently exceeding ten or more, seems to never occur in living species but in *Quercus acuta* Thunberg (*Cyclobalanopsis acuta* Oersted). Also considerable details of structure indicate a very close affinity to this species, though the maximum diameter of pores in this fossil is exceedingly large. On the other hand, although a lot of fossil woods related to the genus *Quercus* have hitherto been reported (cf. Edwards 1931, Boeshore and Jump 1938), no evergreen species are exemplified excepting *Quercinium Wardi* Platen (1908) from the Mio-Pliocene of California and probably *Quercinium hobashiraishi* Ogura (1932) from the Palaeogene of Najima near Fukuoka City, Japan. These two fossils, however, apparently differ from the present fossil in many details. Under the circumstance, the writer chooses here a conventional name, *Quercus* cfr. *acuta* Thunberg.

#### 7. *Quercus anataiensis* (Watari) Watari, comb. nov. (Photo. 3 E)

*Quercinium anataiense* Watari in Jap. Jour. Bot. 11: 399-403, figs. 4, 5, Photo. 2 D-G, 1941 a (Anatai, Iwate Pref. (31-a); Nos. 31129, 31130, 31133, 31142).

Occurrence. (1). Aburato, Yamagata Pref. (35-b); Nos. 35023?, 35209, poorly preserved specimens; collected by the writer in 1950 (2). Tamugimata, Yamagata Pref. (35-g); Nos. 35203, 35215, poorly preserved specimens; collected by Dr. Masami Sato in 1950. (3). Kanomizu, Yamagata Pref. (35-h); No. 35501, well-preserved specimen ca. 20 cm in diameter; collected by Mr. Ichiro Uehara and transmitted by Dr. Ichiro Ohga in 1949. (4). Sodani, Isikawa Pref. (53-a); Nos. 53502, 53509, 53513, 53518, 53519, 53523, 53530, 53531, all excellently preserved, largest ca. 40 cm in diameter; collected by the writer in 1951.

#### 8. *Ulmus crystallophora* Watari, sp. nov. (Photo. 4)

Occurrence. (1). Sinzan, Kitaura, Akita Pref. (34-a); No. 34501, fragment of a large wood, slightly deformed but preservation of internal structure excellent; transmitted by Mr. Ryunosuke Fujii in 1951. (2). Isimoriyama, near Taira City, Fukushima Pref. (33-a);



No. 33003, fragment of excellently preserved specimen, descriptions chiefly based on this specimen; collected by Mr. Sigeru Sato and transmitted by Mr. Sigemoto Tokunaga in 1951. (3). Sodani, Isikawa Pref. (53-a); No. 53510, fragment of a small wood, fairly well-preserved; collected by the writer in 1951.

**Description.** Growth rings very distinct by its ring porosity, breadth fairly broad. Transition between early- and latewood usually very abrupt. Pores of earlywood 2-4 seriate, mostly solitary and in short radial groups, occasionally associated with or interspersed by clusters of smaller vessels; solitary pores mostly oval, up to 320 microns in maximum tangential diameter; vessel segments 150-330 microns in length, perforation plates simple and horizontal or nearly so; intervessel pits circular or more frequently angular through crowding, 7-10 microns in diameter, a few apertures frequently confluent; frequently thin-walled tyloses present. Pores of latewood small, up to 100 microns in maximum tangential diameter, grouped in more or less continuous, festoon-like, tangential or oblique patches; vessel segments with spiral thickenings, perforation plates slanting and simple. Tracheids associated with vasicentric parenchyma abundantly present, somewhat undulate about vessel in longitudinal section. Fibers arranged irregularly in earlywood and more or less in regular radial rows in latewood; circular in cross section, 12-25 microns in diameter; walls fairly thickened. Parenchyma vasicentric and metatracheal-diffuse; vasicentric parenchyma abundantly present, occasionally interspersed among groups of smaller vessels; diffuse parenchyma scattered among fibers, frequently in contact with rays, the latter condition sometimes confused with sheath cells in tangential section; chambered parenchyma quite abundant, several to 10 or more elements bearing rhomboidal crystals in a vertical series. Rays homogeneous, 1-6 cells wide; uniseriate rays rather scarce, 4-9 (12) cells or 80-240 microns high; multiseriate rays fusiform, mostly 4-6 cells wide and up to 1,020 microns in height; individual elements with slightly thickened walls, circular to polygonal with rounded corners and mostly 13-20 microns in diameter in tangential section.

**Affinity.** Many characteristics, especially the particular groups of smaller vessels of the non-porous zone and an abundance of fairly broad essentially homogeneous rays apparently show that the present fossil is a member of *Ulmus*. Among the genus, there is a considerable number of species showing marked resemblance with this fossil in a general structural pattern, such as broad porous zone, luxuriant groups of smaller vessels, and multiseriate rays which are predominantly 4-6 cells wide. Presence of the chambered parenchyma also seems to be a fairly prevailing feature among the species of *Ulmus*, e.g., *U. laciniata* Mayr, *U. parviflora* Jacq., *U. Sieboldii* Davaux var. *coreana* Nakai, and *U. macrocarpa* Hance, but the chambered parenchyma in the fossil is unique in its striking abundance: it occurs so many that two or three sometimes more strands are arranged contiguously side by side both in tangential



and radial sections. We may recognize this special feature as a reliable character of distinct species, for which the new name *Ulmus crystallophora* Watari is proposed.

### 9. *Zelkova Wakimizui* (Watari) Watari, comb. nov.

*Ulmium Wakimizui* Watari in Jap. Jour. Bot. 13: 506-511, fig. 3, Photo. 1 B-D, 1948 a (Hanenisi, Simane Pref. (64-a); Nos. 64401, 64402).

### 10. *Zelkova zelkoviformis* (Watari) Watari, comb. nov.

*Ulmium zelkoviforme* Watari in Jap. Jour. Bot. 11: 405-408, fig. 6, Photo. 3 A-C, 1941 a (Anatai, Iwate Pref. (31-a); No. 31140).

Occurrence. (1). Tobisima I., Yamagata Pref. (35-a); No. 35101, well-preserved specimen ca. 30 cm in diameter; collected by Dr. Masami Sato in 1950. (2). Aburato, Yamagata Pref. (35-b); No. 35028, poorly preserved fragments from a large wood; collected by the writer in 1949. (3). Isagodani, Yamagata Pref. (35-d); No. 35077, well-preserved fragments from a large wood; collected by the writer in 1950. (4). Sakanada, Nima,

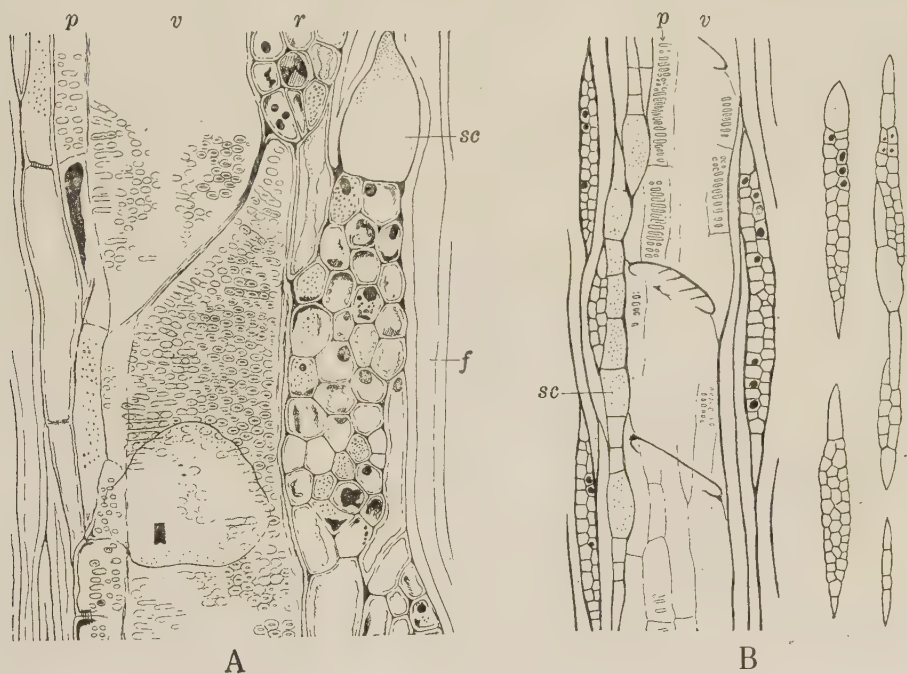


Fig. 6. A, *Laurinium iwamiense* Watari, sp. nov., tangential section showing a vessel *v* with oblique perforation plate, intervessel pits, round or oval pits into parenchyma *p*, thin-walled tyloses *t*; fiber tracheids *f*; a multiseriate ray with a large secretory element *sc* on the margin ( $\times 200$ ). B, *Laurinium kuteense* Watari, sp. nov., the same showing a vessel *v* with two simple and a scalariform perforations, scalariform to opposite pits into vasicentric parenchyma *p*, a parenchyma strand with many secretory elements *sc*, and a few rays all of which are two cells in width; four examples of rays in tangential section are also shown, secretory elements being dotted ( $\times 100$ ).

Simane Pref. (64-b): No. 64534, a well-preserved specimen ca. 25 cm in diameter; collected by the writer in 1941.

Remarks:— Although two species mentioned above are fairly resembling with each other, they are separated by the presence of tyloses and absence of gum-deposits in *Zelkova Wakimizui* and absence of tyloses and presence of gum-deposits in *Z. zelkoviformis*.

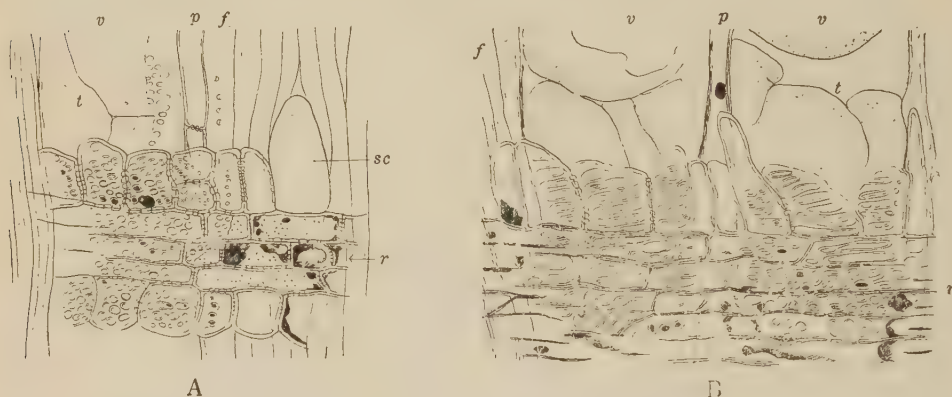


Fig. 7. A, *Laurinium iwamiense* Watari, sp. nov., radial section showing circular pits between ray and vessel ( $\times 150$ ). B, *Laurinium kuteense* Watari sp. nov., the same showing marginal part of a heterogeneous ray with pits into vessels which are much variable in size and form ( $\times 150$ ), (v vessels, t tyloses, p parenchyma, f fiber tracheids, r rays, and sc secretory elements)

# 11. *Laurinium iwamiense* Watari, sp. nov. (Photo. 5; Figs. 6 A, 7 A)

Occurrence. (1). Hanenisi, Simane Pref. (64-a); No. 64404, a hard and excellently preserved specimen ca. 1 m in diameter; collected by the writer in 1941.

Description. Wood diffuse porous. Growth rings faintly distinct, delineated by a few layers of flattened elements at the outer margin of ring; breadth variable, mostly 0.8–7.0 mm. Pores evenly scattered with a tendency of diagonal arrangement, invariable in size or occasionally slightly decreasing through latewood; solitary and occasionally in multiples of a few to several or more, rarely in tangential or diagonal groups or clustered; thin-walled, solitary pores round or somewhat angular, up to 230 microns in maximum tangential diameter. Vessel segments 220–680 microns in length; perforation plates usually slanting and simple or occasionally scalariform with 1–12 bars in small vessels; intervessel pits mostly alternate, circular or oval or frequently angular by mutual contact, 5–10 microns in diameter; 2–several inner apertures frequently confluent; thin-walled tyloses abundantly present. Fiber tracheids forming ground mass, arranged in regular radial rows, angular with rounded corners in outline, all non-septate, 12–35 microns in diameter, 2–5 microns in wall-thickness; pits circular with slit-like and included apertures. Parenchyma vasicentric and metatracheal-diffuse; vasicentric parenchyma



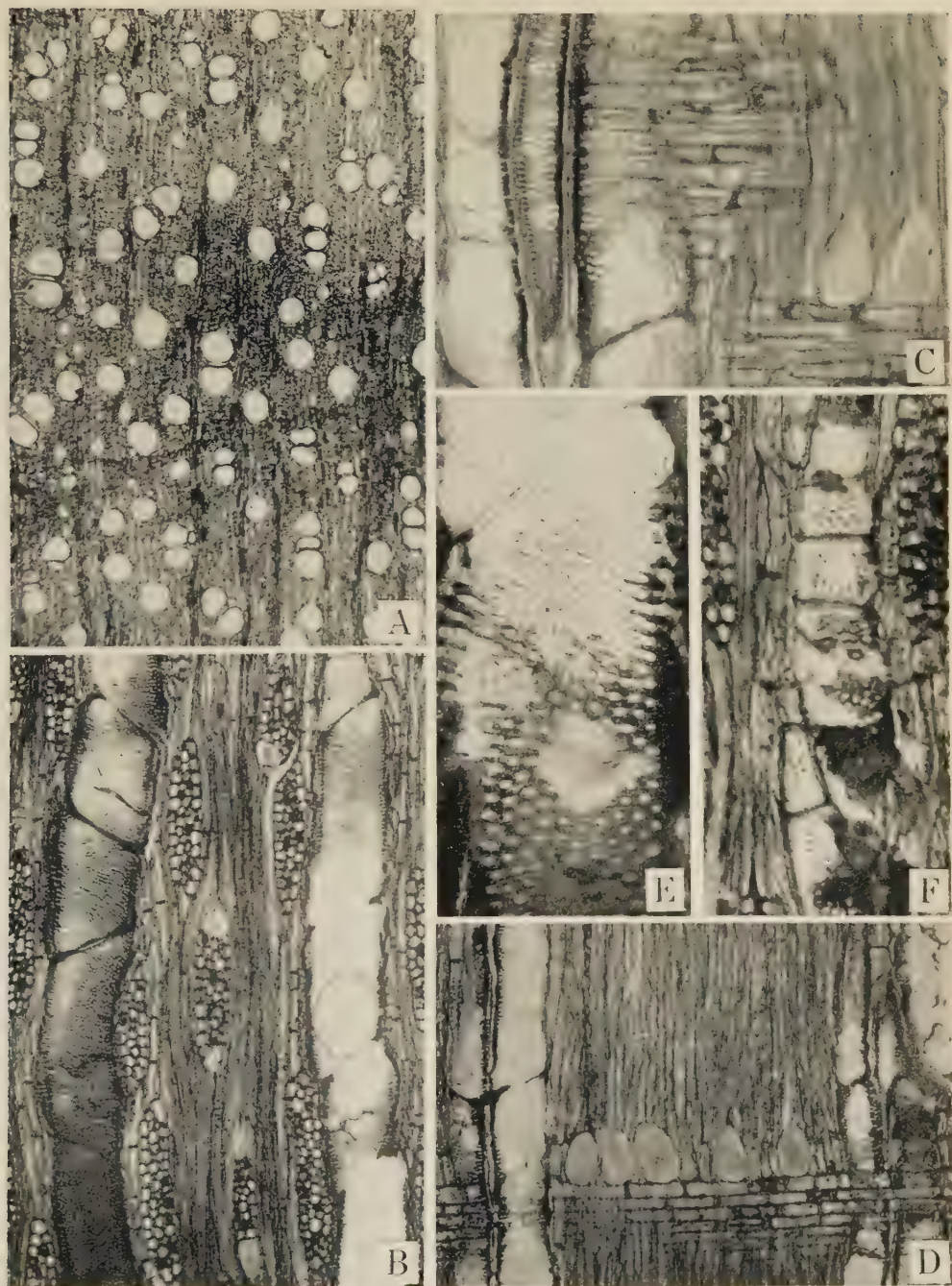


Photo. 5. *Laurinium iwamiense* Watari, sp. nov. A, cross section showing arrangement of pores, boundary of growth rings, rays, etc. ( $\times 30$ ). B, tangential section showing two vessels consisting of relatively short vessel segments, intervessel pits with confluent apertures, thin-walled tyloses, and many rays, some with thin-walled secretory cells on their margins ( $\times 80$ ). C, radial section showing pits between vessels and ray cells, large ovate secretory cells on the ray margin, etc. ( $\times 150$ ). D, radial section showing a ray with many secretory cells on its margin ( $\times 80$ ). E, details of intervessel pits ( $\times 400$ ). F, vasicentric parenchyma strands with circular and minute pits into a vessel ( $\times 150$ ).



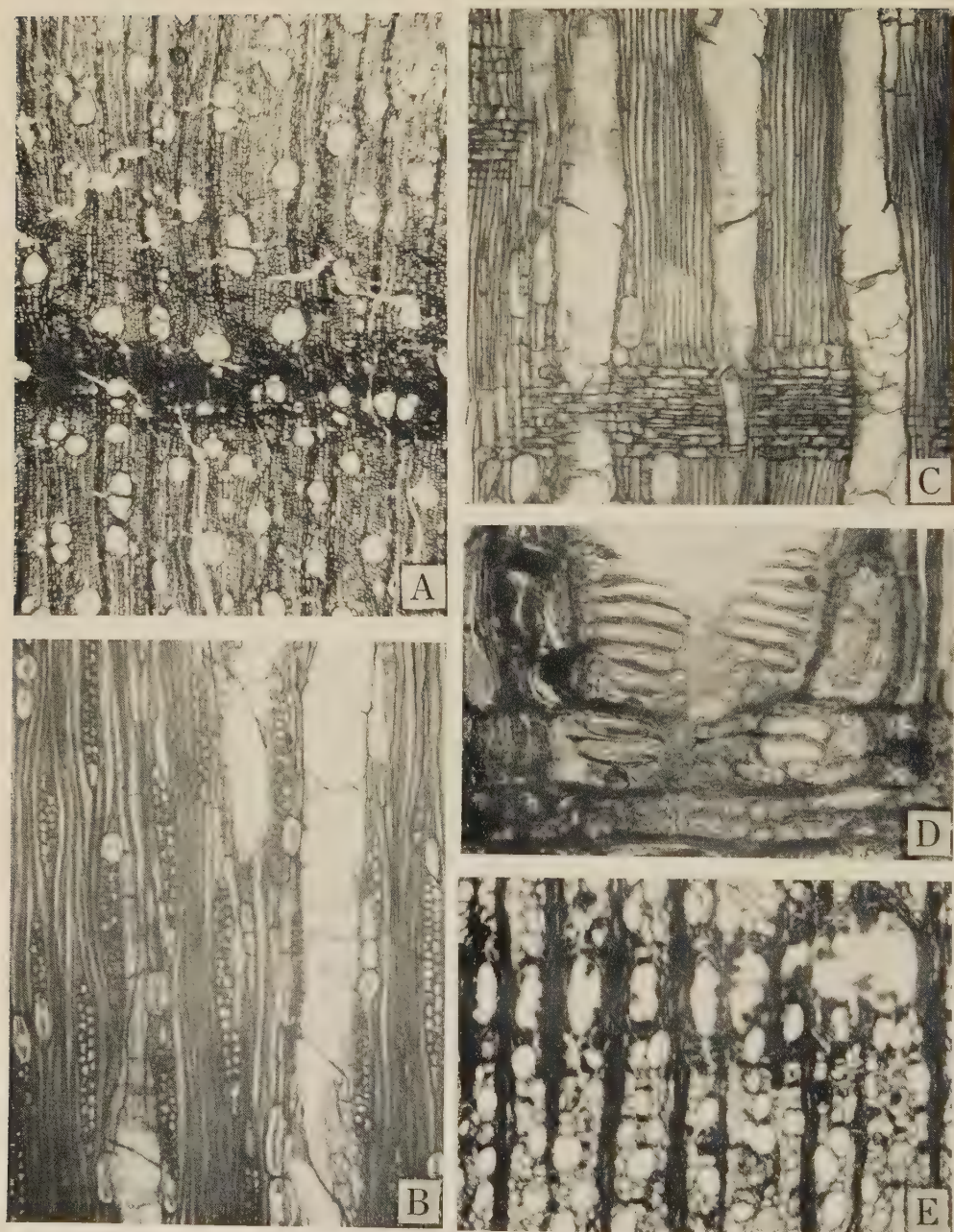


Photo. 6. A-E, *Laurinium kuteense* Watari, sp. nov. A-C, cross, radial and tangential sections respectively (A,  $\times 30$ ; B, C,  $\times 80$ ). D, radial section of a small part of ray showing pits into a vessel ( $\times 400$ ).

E, *Liquidambar formosana* Hance, cross section showing a tangential row of traumatic gum canals ( $\times 80$ ) (No. 42001 from Yokohama City).

forming a narrow sheath about vessels; pits into vessels half-bordered, circular, alternate or opposite in arrangement; diffuse parenchyma scarce; without secretory elements in parenchyma strands, though they are solitarily scattered among fibers. Rays apparently heterogeneous, 1-5 cells wide; uniseriate rays scarce, 2-6 cells or 50-200 microns high, consisting entirely of upright cells; multiseriate rays fusiform, 250-600 microns high, consisting of median procumbent cells and marginal uniseriate wings of 1-2 layers of upright cells; procumbent cells round to angular in tangential section; walls slightly thickened; pits into vessels half-bordered, usually round to horizontally elongated elliptical, mostly arranged oppositely or rarely palisade-like or in a form of a net-work. Large secretory cells quite abundant, usually intermixed among the marginal upright cells or occasionally on the periphery of multiseriate part of rays.

Remarks:—Affinity of the present fossil, *Laurinium iwamiense*, is discussed later together with another species of *Laurinium*, *L. kuteense* (cf. p. 120).

## 12. *Laurinium kuteense* Watari, sp. nov. (Photo. 6; Figs. 6 B, 7 B)

Occurrence. (1). Hanenisi, Simane Pref. (64-a); No. 64411, a hard, decorticated, well-preserved wood ca. 80 cm in diameter and 3 m in height, it was found on the beach of Hanenisi, and is now deposited in front of the building of the Purchasing Guild of Kute Town; collected by the writer in 1941.

Description. Wood diffuse porous. Growth ring faintly distinct, delineated by slight diminution in size of pores and by the presence of a few layers of flattened elements on the outer margin of the ring; breadth mostly 2-3.5 mm. Pores thin-walled, solitary and in radial or diagonal groups of 2 or 3, rarely more, or occasionally in clusters of 3-several; solitary pores circular or somewhat angular, up to 200 microns in maximum tangential diameter. Vessel segments 340-610 microns in length; perforation plates usually slanting, simple and scalariform with feeble or moderately thickened bars; intervessel pits large, circular to oval, 8-17 microns in diameter, outer apertures circular to lenticular, frequently 2 or more inner apertures confluent; thin-walled tyloses abundantly present. Fiber tracheids arranged in regular radial rows, rarely septate, angular in outline, 20-50 microns in diameter, 2.5-5 microns in wall thickness. Parenchyma vasicentric forming a narrow sheath about pores or pore groups; pits into vessels half-bordered, usually scalariform to opposite, rarely alternate; large and swollen secretory elements, often in a vertical series, found in parenchyma strands. Rays heterogeneous, 1-2(3) cells wide; uniseriate rays scarce, linear, 1-5 cells high, consisting wholly of upright cells; multiseriate rays linear to narrow fusiform, 100-550 microns high, consisting of multiseriate procumbent cells and marginal uniseriate wings of 1-3, rarely more, layers of upright cells; walls slightly thickened; pits into vessels half-bordered or occasionally nearly simple; predominantly scalariform or transi-



tional, occasionally circular and opposite, not infrequently palisade-like or in the form of irregular network; large secretory elements abundantly present, mostly intermixed among upright cells, sometimes on the lateral side of rays. Solitary secretory elements also scattered among fiber tracheids.

Affinity. Every features, especially the presence of secretory elements, indicate that these fossils are undoubtedly related to some members of the family Lauraceae. The resembling anatomical features of the woods of certain groups of the family, however, frequently arise many difficulties in their identification. Some authors (Desch 1941, Janssonius 1928, etc.) first of all picked up the distribution of the wood parenchyma and the presence or absence and the distribution of the secretory elements. Although the present fossils seem to resemble, in these connections, to some species belonging to the genera *Cinnamomum*, *Beilschmiedia*, *Machilus*, *Phoebe*, *Notophoebe*, certain *Actinodaphne* and *Listea*, more extensive and critical studies seem needed in obtaining closer affinity of these fossils. However, that these fossils should represent two different species is apparent from the differences of various details as shown in respective descriptions.

Edwards (1931) preferred the generic name *Laurinium* Unger (1845) to all fossil woods of this family, and listed about thirty species which have hitherto been reported under several generic names, i.e., *Laurus*, *Laurinium*, *Lauroxylon* Schenk (1890), *Laurinoxylon* Felix (1883), *Perseoxylon* Felix (1886), *Ocoteoxylon* Schuster (1908), *Cinnamomum* and *Tetranthera*. These species as well as *Laurinium machiliforme* Watari from other localities of Japan (cf. p. 120), however, all seem to differ from the present fossils. Thus the writer proposes here two provisional names *Laurinium iwamiense* and *Laurinium kuteense*.

### 13. *Laurinium machiliforme* Watari

Watari in Jap. Jour. Bot. 11: 409-413, fig. 7, Photo. 3 D, 1941 a (Anatai, Iwate Pref. (31-a); No. 31144).

Occurrence. (1). Tamugimata, Yamagata Pref. (35-g); No. 35214, a fairly well-preserved specimen; collected by Mr. Toshimasa Tanai in 1950.

### 14. *Liquidambar formosana* Hance (Photo. 6 E)

*Ternstroemiacinium Hisauchii* Watari in Jap. Jour. Bot. 13: 261-267, figs. 1-3, Pl. II, 1943 b (No. 41001 from the Pliocene of Minami-Ohta, Yokohama City (indicated by a triangle in solid black in Fig. 1).

Occurrence. (1). Iragawa, Yamagata Pref. (35-c); Nos. 35253, 35255, 35256, 35257, 35268, 35271, generally preserved well, especially excellent in 35271; collected by Mr. Toshimasa Tanai in 1950. (2). South-west suburb of Turuoka City, Yamagata Pref. (35-f); No. 35088, a poorly preserved specimen ca. 35 cm in diameter; transmitted by Dr. Masami Sato in 1951. (3). Isagodani, Yamagata Pref. (35-d); Nos. 35013, 35080, 35081, preservation fairly well in the last specimen; collected by the writer in 1949 and 1950. (4). Tamugimata, Yamagata Pref. (35-g); Nos. 35204, 35205, 35207, 35209, 35210, 35211, preserva-



tion rather poor excepting No. 35211, collected by Dr. Masami Sato and Mr. Toshimasa Tanai in 1950. (5). Nata-mura, Isikawa Pref. (35-b); No. 53201, a poorly preserved erect trunk ca. 30 cm in diameter from a stone pit; collected by Mr. Seiji Sugiura in 1950. (6). Sodani, Isikawa Pref. (53-a); Nos. 53521, 53522, 53537, 53539, preservation is excellent in Nos. 53537 and 53539; collected by the writer in 1951. (7). Hanenisi, Simane Pref. (64-a); No. 64403, rather poorly preserved specimen ca. 20 cm in diameter; collected by the writer in 1941. (8). Taziri, Nima, Simane Pref. (64-b); Nos. 64502, 64521, 64540, all preserved fairly well, largest ca. 30 cm in diameter; collected by the writer in 1941.

Additional remarks on structure and affinity. Presence of evenly scattered, angular and thin-walled, numerous small pores, very long vessel segments with extremely slanting perforation plates mostly with 15-30 bars, spiral thickenings restricted to the ligular ends of the vessel segments, predominance of the scalariform type in intervessel pitting, imperforate tracheary elements exclusively of the fiber tracheid category, metatracheal-diffuse parenchyma, heterogeneous rays which are mostly 1-3 (4) cells wide and provided mostly with well-developed uniseriate wings in multiseriate rays, and frequent occurrence of tangential rows of traumatic gum canals,—these apparently primitive anatomical features associated with the last-mentioned worth-noticing abnormal structure clearly indicate that the present fossil should be a member of *Liquidambar*. It was unfortunate in this connection that a lack of this particular characteristic through a careful observation on a considerable number of slides led the writer erroneously to place an excellently preserved specimen from the Pliocene of Yokohama City to the Ternstroemiaceae (Watari 1943 b). A few additional slides, however, apparently contain this structure. Above-mentioned some twenty-five specimens are all similar in essential details to those of the specimen ever described, though root or branch wood naturally show a slight deviation in some features. On the ground of wood anatomy, however, a decided distinction between two important species of the genus, i.e., *Liquidambar formosana* Hance and *L. styraciflua* L., is rather difficult excepting that the fiber tracheids seem, if the observation is restricted to a normally grown stem, slightly more abundant in *L. formosana*, causing somewhat denser aspect of its cross section than that of *L. styraciflua*. The present fossil falls in this regard to the species from Eastern Asia. It also strongly supports writer's opinion that the fossil leaves of *Liquidambar* from the Miocene of Japan including some localities mentioned above are only but of *Liquidambar formosana* type (cf. Endo and Morita 1932, Endo 1948).

#### 15. *Gleditsia* cfr. *japonica* Miquel (Photo. 7 A, B).

Occurrence. (1) Tamugimata, Yamagata Pref. (35-g); No. 35212, collected by Mr. Toshimasa Tanai in 1950; preservation rather poor, markedly deformed, details of the membrane structure are observable only in some places.

Descriptions. Growth rings distinct by its ring porosity. Porous zone broad, up to 7 pores in breadth; pores in earlywood, solitary and in radial or oblique groups of a few; solitary pores mostly oval, up to 330 microns in maximum

tangential diameter, rather thin-walled excepting common walls which are fairly thickened; pores in latewood clustered or in short radial groups; perforation plate simple and almost horizontal to fairly slanting; intervessel pits circular to oval, frequently angular by mutual contact, opposite to alternate in arrangement, mostly 5–8 microns in diameter, 2–several inner apertures frequently confluent; spiral thickenings seem present in smaller vessels of latewood; gum-deposits present almost in every vessels. Fibers forming a ground mass alternating with bands of parenchyma in latewood; thick-walled and 8–13 microns in diameter. Parenchyma abundantly present; in the first half of earlywood parenchyma form a ground mass; in the transitional region between early- and latewood, vasicentric parenchyma form a few to several layers of complete sheath; in latewood, aliform or more frequently confluent to form tangential or oblique, more or less irregular, broad bands; chambered elements with solitary crystals occasionally present. Rays homogeneous, 1–12 cells wide; uniseriate rays scarce, up to 11 cells high; multiseriate rays narrow fusiform, frequently flanked by incomplete sheath cells.

Affinity. Conspicuous porous zone reaching to 6 or more layers of large vessels, frequent presence of gummy occlusion in vessels, tangential or oblique fairly broad bands of confluent parenchyma in which groups of small vessels of latewood are enclosed, homogeneous rays reaching to a considerable width, all of these conspicuous features indicate, associated with many details, an affinity to the genus *Gleditsia*. This genus comprises of about twelve species from Eastern and Central Asia, North and South America and tropical Africa, and their wood structure seems to differ but slightly from species to species. Unfortunately the preservation of present specimen is not well and enables me to perform rigid comparisons with living representatives. But, so far as these are observable, all details fall into the structural range of our *Gleditsia*. Although we expect a discovery of some better specimens for further study, it is probably sure that this fossil is either the same with or closest to *Gleditsia japonica* Miquel.

16. *Acer* cfr. *amoenum* Carr. (Photo. 7 C, D)

Occurrence. (1) Isagodani, Yamagata Pref. (35-d); No. 35018, rather poorly preserved specimen; collected by the writer in 1949.

Description. Wood diffuse porous. Growth rings faintly distinct and fairly broad, delineated by a few to several layers of flattened elements on the outer margins of the ring. Pores evenly scattered, invariable in size or slightly diminishing towards outer margin; solitary or occasionally in multiples of 2–4; solitary pores oval, up to 75 microns in maximum tangential diameter. Vessel segments 170–550 microns in length, perforation plates simple and slanting at a variable angle; intervessel pits alternate, mostly angular through crowding, mostly 6–8 microns in diameter; rather coarse spiral thickenings distinct in



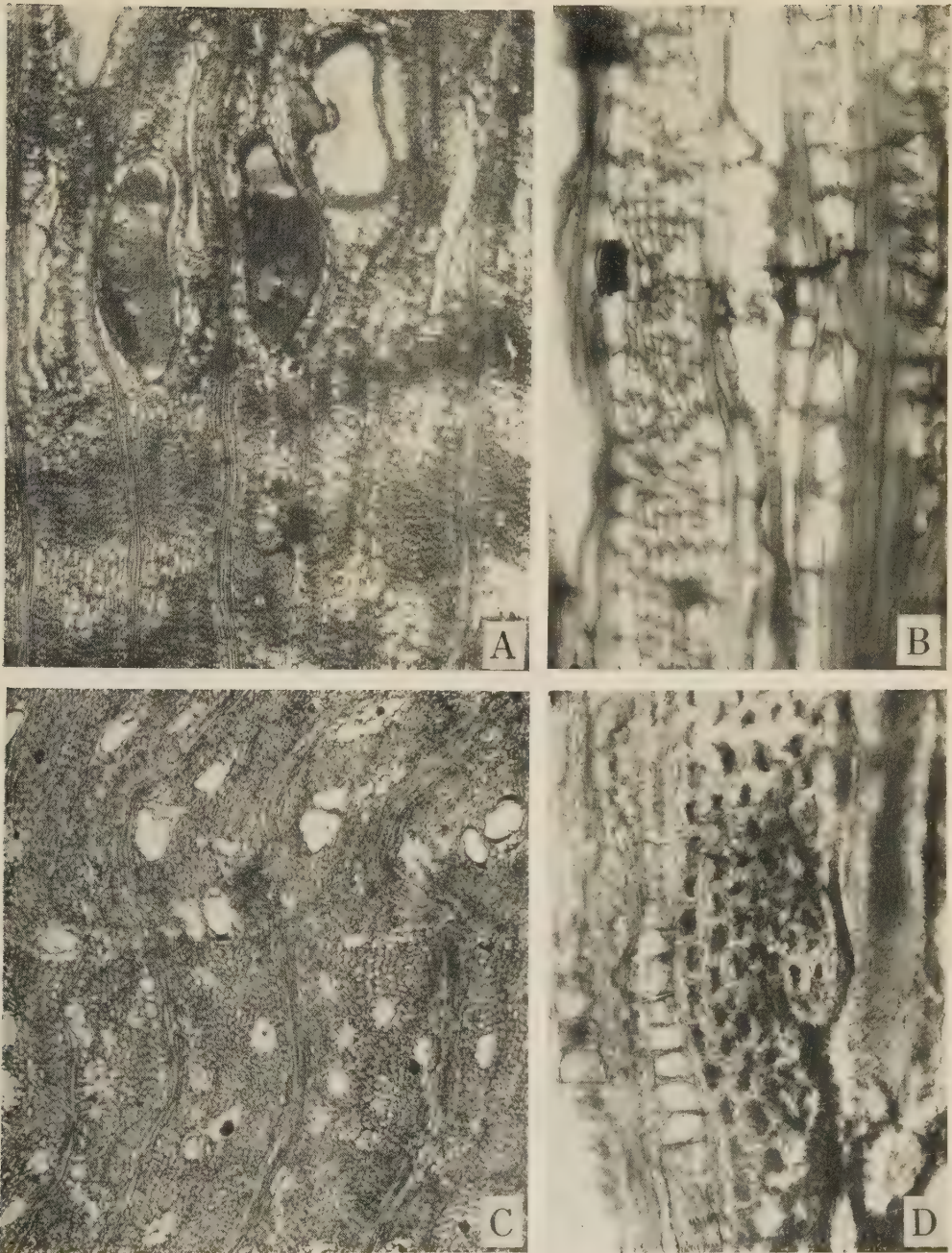


Photo. 7. A, B, *Gleditsia* cfr. *japonica* Miquel. A, cross section with a boundary of growth rings, showing several large pores at the beginning of the ring (fairly deformed) and an alternation of groups of fibers (dark area) and confluent parenchyma (light area) in which groups of smaller vessels are enclosed ( $\times 80$ ). B, tangential section showing a part of broad ray with sheath cells (markedly deformed) and a parenchyma strand with crystals (on the right side) ( $\times 400$ ). C, D, *Acer* cfr. *amoenum* Carr. C, cross section with a boundary of growth rings showing arrangement of pores ( $\times 80$ ). D, tangential section showing a part of broad ray and a parenchyma strand with crystals ( $\times 400$ ).



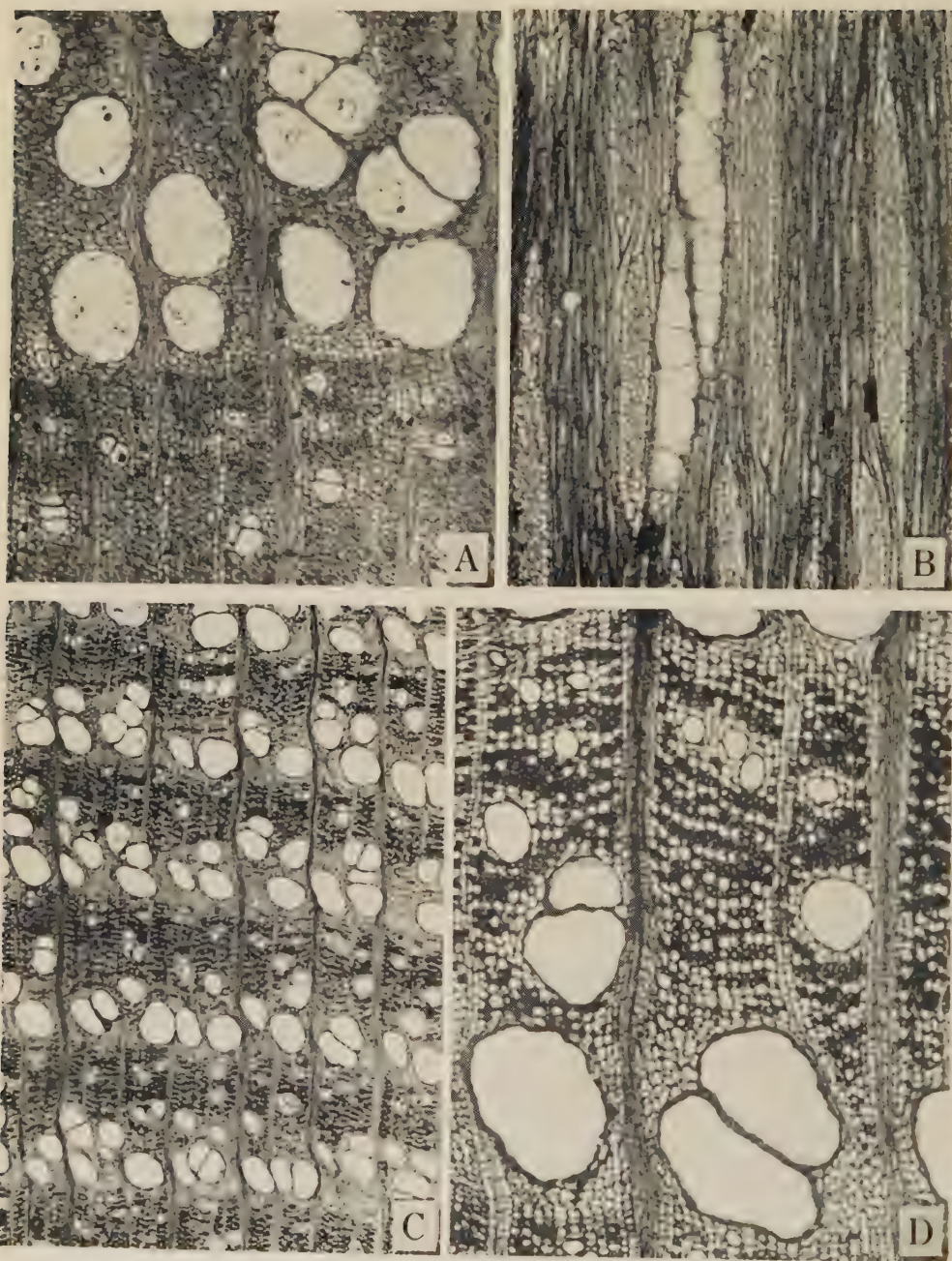


Photo. 8. A, B, *Hovenia dulcis* Thunberg. A, cross section with a boundary of growth rings showing arrangement of pores, confluent parenchyma in the latewood, etc. ( $\times 50$ ). B, tangential section showing two vessels with thin-walled tyloses, a few uniseriate and several multiseriate rays ( $\times 80$ ). C, D, *Reevesia miocenica* Watari, sp. nov. C, cross section under a low magnification showing arrangement of pores in several growth rings ( $\times 20$ ). D, cross section containing a growth ring, showing arrangement of pores, some rays, and bands of metatracheal parenchyma in alternation with groups of fibers in the latewood ( $\times 80$ ).

some vessels; dark substances suggesting gum-deposit frequently present. Fiber tracheids forming ground mass arranged in regular radial rows, angular, 15-20 microns in diameter, walls with medium thickness. Parenchyma vasicentric scanty, metatracheal-diffuse and terminal; chambered parenchyma thin-walled and slightly swollen, occasionally 10 or more elements in a vertical series. Rays essentially homogeneous, 1-6 (9) cells wide; uniseriate rays 2-15 (20) cells high; multiseriate rays narrow fusiform and up to 1,200 microns in height; cells from multiseriate part polygonal in tangential section, 10-15 microns in diameter; all walls slightly thickened; pits into vessels angular, arranged alternately in 2-3 horizontal rows.

Affinity. An assortment of the following characteristics apparently shows that this fossil is a member of *Acer*, i.e., evenly scattered vessels which are mostly solitary and in short multiples, medium size both in diameter and length of vessels, angular and fairly large intervessel pits, presence of rather coarse spiral thickenings of vessels, presence of scanty vasicentric, metatracheal-diffuse and terminal parenchyma, and essentially homogeneous rays. Frequent occurrence of the chambered parenchyma and fairly broad rays sometimes reaching 9 cells wide are prominent characteristics of the present fossil. My own observation on available materials covering the majority of Japanese *Acer* as well as various descriptions on Far Eastern and North American species (e.g., Kanehira 1921 a, b, 1926, Brown, Panshin and Forsaith 1949, Yamabayashi 1938, etc.) apparently show that there are many species which show one of these two characteristics, whereas those possessing them simultaneously are quite rare. *A. maudshuricum* Maxim. and *A. amoenum* Carr. seem only the species comparable to the present fossil in this connection. In the first species, however, rays frequently tend to be heterogeneous and *Acer iwatense* Watari (cf. p. 125) is a fossil representative of this category. Rather poor preservation of this fossil, however, unfortunately obstructs a rigid comparison on further details, nevertheless data available here all indicate a probable affinity to *Acer amoenum*. The writer, therefore, chooses here conventionally *Acer* cfr. *amoenum* Carr.

**17. *Acer iwatense* Watari, comb. nov.**

*Acerinium iwatense* Watari in Jap. Jour. Bot. 11: 431-437, fig. 5, Photo. 3, 1941 b (Nezori, Iwate Pref. (31-b); Nos. 31106, 31122).

**18. *Meliosma Oldhami* Miquel.**

Watari in Bot. Mag. Tokyo, 62: 83-86, 1 fig., Pl. II, 1949 (Taziri, Nima, Simane Pref. (64-b); Nos. 64505-64510).

**19. *Leea eo japonica* Watari.**

Watari in Bot. Mag. Tokyo, 64: 1-5, figs. 1-2, 1951 (Sakanada, Nima, Simane Pref. (64-b); Nos. 64526, 64527, 64529, 64531, 64533).



**20. *Hovenia dulcis* Thunberg (Photo. 8, A. B)**

Occurrence. (1). Sodani, Isikawa Pref. (53-a); No. 53512, excellently preserved specimen; collected by the writer in 1951.

Description. Wood ring porous. Breadth of growth rings variable, mostly 1-5 mm. Large pores mostly 2-3 layered, rapidly diminishing in size through latewood; pores solitary and in multiples of 2-3 or rarely more, occasionally in short tangential or oblique groups or clustered; pores or groups of pores further show a distinct diagonal or tangential arrangement; solitary pores circular to oval, largest up to 275 microns in tangential diameter; common walls of vessel groups fairly thickened. Vessel segments 140-330 microns in length, perforation plates mostly slightly slanting and exclusively simple; intervessel pits mostly angular by mutual contact, 8-10 microns in diameter, 2-several inner apertures frequently confluent; thin-walled tyloses present almost in every vessels. Fibers forming a ground mass arranged in regular radial rows, 20-35 microns in diameter, walls markedly thickened. Parenchyma vasicentric and terminal; vasicentric parenchyma forming a narrow sheath about large pores in earlywood and aliform and frequently confluent in latewood; terminal parenchyma mostly 1-5 layered; pits into vessels frequently scalariform; chambered parenchyma frequently present, 1-5 elements containing polygonal crystals in a vertical series. Rays heterogeneous provided frequently with more or less distinct sheath cells, 1-7 cells wide; uniseriate rays scarce, 2-12 cells high, consisting chiefly of a layer of marginal upright cells and median squarish cells; multiseriate rays narrow fusiform, mostly 5-7 cells wide, marginal upright cells mostly 1 cell high, multiseriate part consisting of a central core of typical procumbent cells and peripheral sheath cells; upright and squarish cells frequently with polygonal crystals.

Affinity. Ring porosity with relatively few number of latewood vessels which are solitary and in small groups and show a distinct diagonal or tangential arrangement, and rather indistinct patches of aliform and confluent parenchyma, these gross aspects in a cross section glancingly suggest an affinity of this fossil to either genera, such as *Ailanthus*, *Picrasma*, *Rhamnella*, *Hovenia* or *Fraxinus*. Affinity to *Fraxinus*, however, is out of question in the heterogeneity of rays in the present fossil, whereas all details given above show a good identity to *Hovenia dulcis* Thunberg, a monotypic representative of the genus showing a wide-spread distribution throughout Eastern Asia including Japan.

**21. *Reevesia miocenica* Watari, sp. nov. (Photo. 8 C, D; Photo. 9)**

Occurrence. (1). Iragawa, Yamagata Pref. (35-c); No. 35252, excellently preserved specimen, the following description is chiefly based on this specimen; collected by Mr. Toshimasa Tanai in 1950. (2). Isagodani, Yamagata Pref. (35-d); No. 35008, well-preserved specimen; collected by Dr. Masami Sato in 1949. (3). Tamugimata, Yamagata



Pref. (35-g); No. 35213, well-preserved specimen; collected by Mr. Toshimasa Tanai in 1949.

**Description.** Growth rings very distinct by its ring porosity; breadth fairly uniform, mostly 1-2 mm. Large pores of earlywood 2-3 layered; pores solitary or 2-3 (4) in radial, tangential or diagonal groups or in clusters; solitary pores circular or oval, up to 350 microns in maximum tangential diameter, thin-walled, common walls of pore groups slightly thickened. Vessel segments 170-300 microns in length, perforation plates simple and horizontal or nearly so. Pores from latewood abruptly diminishing in size, from 160 microns sinking to 28 microns towards outer margin of ring; solitary pores predominate in some rings, then groups of 2-several predominate in some others; perforation plates also simple and usually slanting. Intervessel pits alternate, circular to oval in outline, 2-4 microns in diameter, with oval pit apertures; spiral thickenings faintly distinct in some vessels; thin-walled tyloses abundantly present. Fibers developed chiefly in latewood, alternating with metatracheal parenchyma bands; polygonal in outline, 13-37 microns in diameter and 4.5-9.5 microns in wall thickness. Parenchyma in earlywood well-developed and forming a ground mass. Parenchyma in latewood paratracheal, metatracheal and metatracheal-diffuse; paratracheal parenchyma vasicentric, forming a narrow sheath about pores; metatracheal parenchyma storied, in 1 or rarely 2 layers of short or long somewhat wavering tangential patterns in alternation with 1-several layers of thick-walled fibers; two types of parenchyma present, i. e., fusiform and strands composed of 2-several elements; chambered parenchyma occasionally present, several elements containing polygonal crystals in a vertical series. Rays heterogeneous, 1-10, sometimes 12 or more, cells wide, characterized by the presence of well-marked tile cells and well-developed sheath cells; uniseriate rays fairly abundant, mostly 2-15, rarely more, cells high; multiseriate rays fusiform flanked by short uniseriate margins of 1-2, rarely several, cells high; sheath cells 1-2 (3) layered and sheathing completely a central core composed of typical procumbent cells with smaller diameter; multiseriate rays of 2-4 cells wide frequently devoid of typical procumbent cells; sheath cells squarish to horizontally elongated rectangular in radial section, walls slightly thickened, rarely with rhomboidal figures suggesting the presence of simple crystals; typical procumbent cells 15-35 microns in diameter and 35-120 microns in radial length, walls slightly thickened; tile cells very distinct in every surfaces, especially in cross and radial sections in offering palisade-like patterns, distributed among sheath as well as central procumbent cells; extremely thin-walled;  $18-33 \times 25-45 \times 9-18$  microns in tangential, vertical and radial diameters respectively.

**Affinity.** An outstanding characteristic of the present fossil is the presence of the tile cells by which the extent must be considered for its affinity seems to be extremely limited. According to the definition by the Committee on Nomenclature, International Association of Wood Anatomists (1933), the tile

cells are "special type of apparently empty upright or square ray cells of approximately the same height as the procumbent cells and occurring in intermediate horizontal series usually interspersed among the procumbent cells." Chattaway (1932) came to a conclusion after her extensive study covering two thousands woods of different genera and families, that this type of ray cells confined only to some genera of the Tiliaceae, Bombacaceae and Sterculiaceae, and she promised two extreme forms of tile cells, i. e., *Durio* and *Pterospermum* types.

The *Durio* type is characterized in that "the tile cells are conspicuous feature of the transverse and radial sections of the wood, but they are not always distinguishable on the tangential section", while in the *Pterospermum* type, "the rays are composed of two kinds of cell which can be recognized on all sections, but on the transverse section the tile cells do not form a conspicuous feature of the wood and they might pass for ordinary marginal ray cells if only that section were observed." The following genera are placed in her respective types, that is,

*Durio* type:—Sterculiaceae—*Guazuma*, *Kleinhofia*, *Leptonychia*, *Reevesia*, *Scaphopetalum* and *Triplochiton*; Tiliaceae—*Columbia*, *Luchea* and *Grewia* (in part); Bombacaceae—*Durio*, *Cullenia*, *Neesia*, *Boschia* and *Coelostegia*.

*Pterospermum* type:—Sterculiaceae—*Pterospermum*; Tiliaceae—*Belotia*, *Duboscia* and *Grewia* (in part); Bombacaceae—*Hanpea* and *Ochroma*.

She further mentioned that the division of these two types is only an arbitrary one,—there is a complete sequence of intermediate forms, for example, *Grewia stylocarpa* is a borderline type and might be included in either, and also *Guazuma* and *Reevesia* are two intermediate forms, in both of which the tile cells are like those in *Pterospermum* type when seen on the tangential section. The fossil seems, in this connection, to belong a certain intermediate form.

On the other hand, the ring porosity with large vessels and the presence of regular uniseriate bands of metatracheal parenchyma alternating with groups of thick-walled fibers in the latewood are other prominent features of the present fossil. Seeking the possessor of these features among the members which characterized with tile cells, all of the Tiliaceae and Bombacaceae as well as the most of the Sterculiaceae should be omitted by their decided diffuse porosity. Within the range of the writer's knowledge, *Reevesia formosana* Hayata which is endemic to Formosa is only a species showing close resemblance to the fossil not only in above mentioned characteristics but also in many other details (Kanehira 1921). However, the length of vessel segments in this species are slightly longer, maximum tangential diameters of large vessels are smaller and the breadth of rays are narrower than the fossil. It will be appropriate to consider that *Reevesia miocenica* Watari here proposing is a fossil form closest to *Reevesia formosana*.



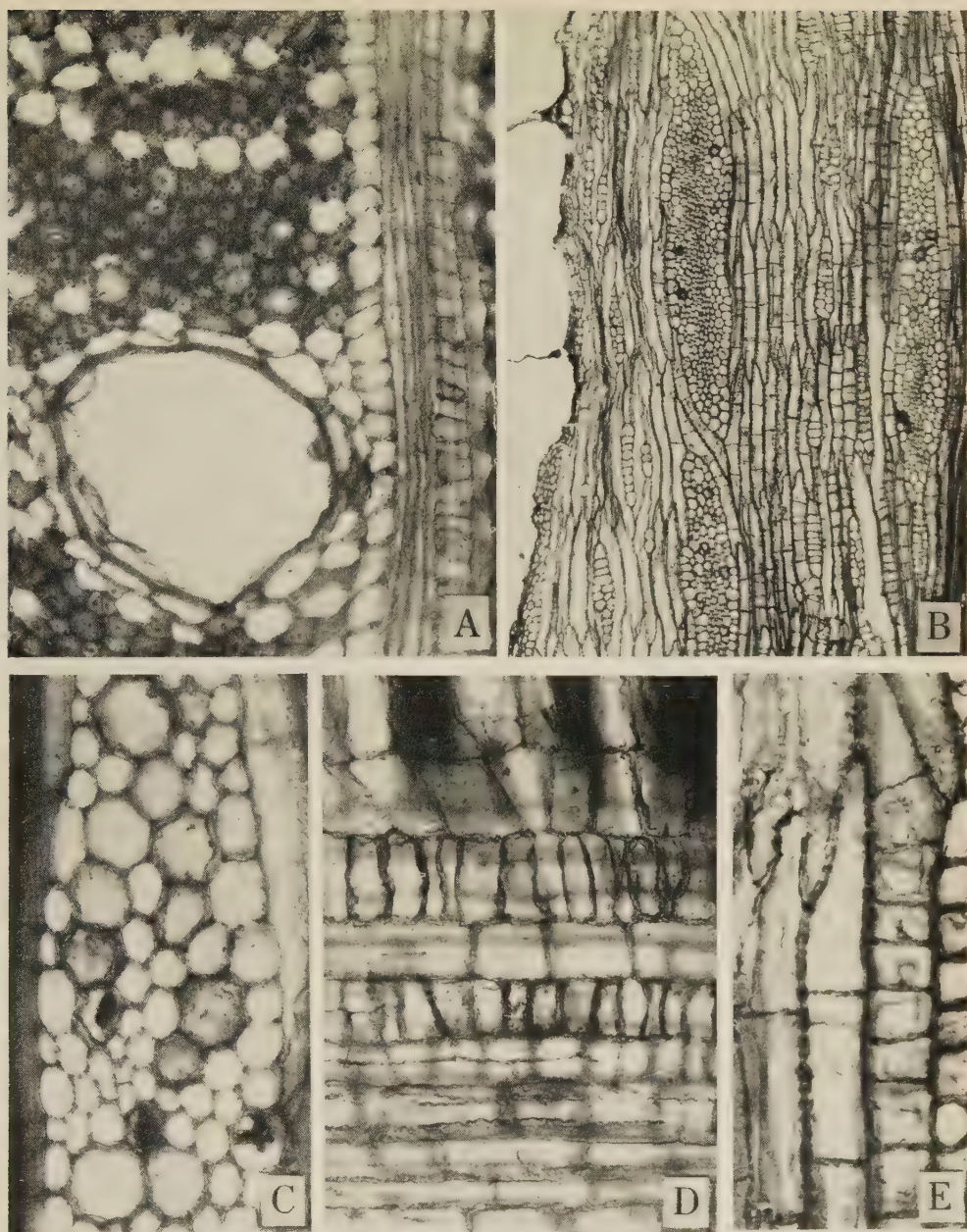


Photo. 9. *Reevesia miocenica* Watari, sp. nov. A, cross section under a higher magnification showing a pore with a narrow sheath of vasicentric parenchyma, groups of thick-walled fibers in alternation with bands of metatracheal parenchyma, a few diffuse parenchyma among fiber groups, and a multiserial ray with procumbent and tile cells (on both margins) ( $\times 300$ ). B, tangential section through early wood, showing a part of vessel (left side), several uniseriate and a few multiserial rays, and storied arrangement of parenchyma strands ( $\times 70$ ). C, tangential section through a part of multiserial ray showing several tile cells which are slightly larger and darker than the other elements ( $\times 400$ ). D, a part of multiserial ray in radial section, showing a layer of upright cells on the upper margin, several layers of procumbent cells on the lower side and two radial series of tile cells which are interspersed by a row of squarish cells ( $\times 400$ ). E, tangential section showing a part of storied parenchyma with a chambered strand (on the right side) ( $\times 400$ ).



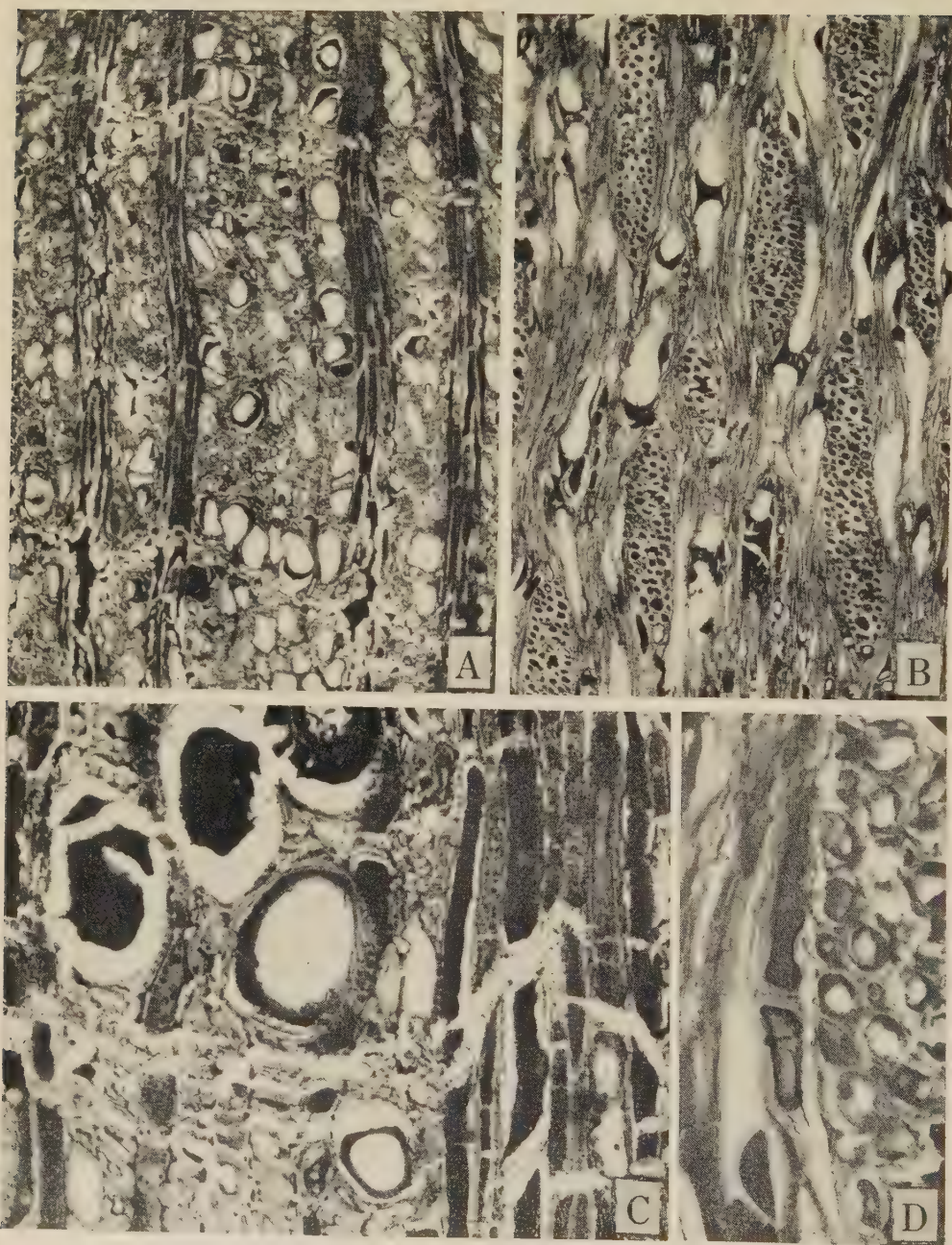


Photo. 10. *Elaeagnus semiannuliporosa* Watari, sp. nov. A, cross section with two boundaries of rings, showing arrangement of pores, several broad rays, etc. ( $\times 80$ ). B, tangential section showing vessels with gum deposits, and many uniseriate and multiseriate rays ( $\times 80$ ). C, cross section with a boundary of growth rings under a higher magnification, showing several large pores with gum deposits at the beginning of the ring, a few layers of flattened fibrous elements on the outer margin of the ring and a broad ray (on the right side) ( $\times 400$ ). D, tangential section under a higher magnification showing a short parenchyma strand composed of 2 units contiguous to the periphery of a broad ray ( $\times 800$ ).

22. *Elaeagnus semiannuliporosa* Watari, sp. nov. (Photo: 10; Fig. 8).

Occurrence. (1). Tobisima I., Yamagata Pref. (35-a); No. 35105; transmitted by Mr. Toshimasa Tanai in 1950. (2). Isagodani, Yamagata Pref. (35-d); No. 35071, preservation is fairly well in some places, description is chiefly based on this specimen; collected by the writer in 1949. (3). Yutagawa Hot Spring, Yamagata Pref. (35-e); Nos. 35020, 35021, both ca. 30 cm in diameter; collected by the writer in 1949.

Description. Wood semi-ring porous. Growth rings faintly distinct, breadth mostly 1-3 mm. Pores at the beginning of the ring slightly larger and frequently arranged contiguously in 1 or rarely 2 rows; pores of latewood evenly scattered, solitary, or 2-several in radial or tangential groups or sometimes clustered; solitary pores circular to oval in gross outline, somewhat angular and thin-walled; maximum tangential diameter up to 85 microns at



Fig. 8. *Elaeagnus semiannuliporosa* Watari, sp. nov., cross section through a small part of wood showing several vessels *v* with gum deposits, thick-walled fibers, oblique and wavering bands of metatracheal parenchyma *p*, some diffuse parenchyma, and a ray *r* ( $\times 200$ ).

the beginning of the ring and up to 75 microns in latewood. Vessel segments 350-600 microns in length, perforation plates exclusively simple and slanting at a variable angle; intervessel pits alternate to opposite, circular to oval or frequently angular through crowding, 4-7 microns in diameter, pit apertures lenticular, horizontal to oblique; spiral thickenings sometimes faintly distinct; small papilla-like projections occasionally present on the inner surface; gum



deposits present in almost every vessels. Fibers thin-walled, all non-septate; fairly irregular in arrangement, polygonal, 15-30 microns in diameter; fine spiral thickenings occasionally present. Parenchyma metatracheal, metatracheal-diffuse, and probably also terminal; metatracheal parenchyma mostly in short uniseriate lines which are more or less oblique or wavering; parenchyma of two types mixed, i.e., fusiform and strands, the latter mostly composed of 2 units, both 110-250 microns in length; all elements occluded with dark substances. Rays heterogeneous, rarely almost homogeneous, 1-9 cells wide; uniseriate rays linear, mostly 2-17 cells high; multiseriate rays fusiform, up to 1,100 microns in height, mostly flanked by 1-2 marginal layers of upright cells, procumbent cells polygonal with rounded corners and 10-25 microns in diameter in tangential section; all walls fairly thickened; pits into vessel crowded, angular, mostly arranged alternately in 2-3 horizontal rows; all elements occluded with dark substances.

Affinity. The reference of the present fossil to *Elaeagnus* was settled after a prolonged consideration and a careful comparison with some descriptions (Kanehira 1921 a, b; Yamabayashi 1939) and my own observations on a considerable number of living representatives, notwithstanding most available characteristics all fall into the structural range of the genus, for instances, an abundance of broad rays, occlusion of gum deposits in the vessels, an indication of spiral thickenings both in vessels and fibrous elements though they are faintly distinct only in some places, and especially more or less oblique or wavering patches of uniseriate bands composed of fusiform parenchyma and parenchyma strands.

As to "semi-ring porous" in the preceding description, size of pores at the beginning of the ring in the fossil differs but slightly from these of the latewood, whereas all living representatives, so far as their woods have been treated, all ascribed as decidedly ring porous. My critical observations covering most systematically important species of Japan seem me not but recognize the same fact. It calls fortunately our attention that in all evergreen oleasters, i.e., *E. pungens* Thunberg, *E. glabra* Thunberg and *E. macrophylla* Thunberg, as well as in a certain half-evergreen species (*E. Yoshinoi* Makino), diameter of large vessels at the beginning of the ring are sometimes fairly inconstant from ring to ring. A semi-ring porosity, quite similar to the case of this fossil, are occasionally observed all around a ring or with a decided ring porosity in a varying ratio. These facts probably indicate that these species are extraordinarily sensible to some environmental factors which rather exaggeratively reflect in the structures from ring to ring. We accept these as factors, such as slight changes of the temperature and humidity through successive winters. Also some artificial incidents such as topping or cutting of some branches may possibly count as one of factors considering the circumstances under which they were growing. A perfect semi-ring porosity



may, therefore, possibly occurs under a certain suitable condition. The writer venture to propose here a new name *Elaeagnus semiannuliporosa* Watari as an extinct species holding the past environmental condition in its structure.

**23. *Cornus simanensis* (Watari) Watari, comb. nov.**

*Cornoxydon simanense* Watari in Jap. Jour. Bot. 13: 511-514, Figs. 4, 5, Photo. 2 A, B, 1948 a (Hanenisi, Simane Pref. (64-a); No. 64406).

**24. *Paulownia hondoensis* (Watari) Watari, comb. nov.**

*Paulownioxylon hondoense* Watari in Jap. Jour. Bot. 13: 514-517, Figs. 6, 7, Photo 2 C, D, 1948 a (Hanenisi, Simane Pref. (64-a); No. 64410).

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